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R&D

Research and Development: U.S. Trends and International Comparisons

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This publication is part of the *Science and Engineering Indicators* suite of reports. *Indicators* is a congressionally mandated report on the state of the U.S. science and engineering enterprise. It is policy relevant and policy neutral. *Indicators* is prepared under the guidance of the National Science Board by the National Center for Science and Engineering Statistics, a federal statistical agency within the National Science Foundation. With the 2020 edition, *Indicators* is changing from a single report to a set of disaggregated and streamlined reports published on a rolling basis. Detailed data tables will continue to be available online.

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Executive Summary

Key takeaways:

- The U.S. research and experimental development (R&D) performance reached $667 billion in 2019 and an estimated $708 billion in 2020, reflecting increases in all sectors (business, higher education, the federal government, nonprofit organizations, and others) but mostly in the business sector.
- Adjusted for inflation, growth of the U.S. R&D total averaged 3.8% annually from 2010 to 2019, well above the 2.2% growth of U.S. gross domestic product (GDP) over the same period.
- The U.S. national R&D intensity (R&D-to-GDP ratio)—a key measure of R&D investment—has also increased, from the highs of recent years of 2.79% in 2016 and 2.95% in 2018 to 3.12% in 2019 and then to an estimated 3.39% in 2020.
- The United States remains the global leader in R&D performance (28% of global R&D in 2019), followed by China ($526 billion, or 22% of global R&D). China's current average annual rate of increase (2010–19), however, is almost double the U.S. rate.
- Global R&D performance is concentrated in a few countries. The United States, China, Japan, Germany, South Korea, France, India, and the United Kingdom jointly accounted for about 75% of global R&D performance in 2019. The global concentration of R&D performance continues to shift from the United States and Europe to East-Southeast and South Asia.
- Businesses are the predominant performers (75% in 2019) and funders (72%) of U.S. R&D. This sector performs most of U.S. R&D classified as experimental development, more than half of applied research, and a sizable (and increasing) share of basic research (32% in 2019).
- Higher education institutions (12% in 2019) and the federal government (9%) are the second- and third-largest performers of U.S. R&D. Higher education institutions are the largest performers of basic research. Both have experienced declines in their shares of the U.S. performance total since 2010.
- The federal government continues to be an important source of support for all R&D-performing sectors and remains the largest funder of basic research. The share of federally funded R&D, however, has been on a path of decline since 2010 (from 31% in 2010 to 20% in 2019), and the share of federally funded basic research has also consistently declined (from 52% in 2010 to 41% in 2019). These declines stem, in part, naturally from the large increases in R&D funding and performance by the business sector in recent years. This trend, however, indicates that federal funding has not kept up with the increases in other sectors.

Scientific discoveries, new technologies, and inventive applications of cutting-edge knowledge are essential for success in the competitive global economy and in addressing challenges and opportunities in diverse societal areas such as health, environment, and national security. Consequently, the strength of a country's overall R&D enterprise—both the public and private sectors—is an important marker of current and future national economic advantage and of the prospects for societal improvements at the national and global levels.

The U.S. R&D enterprise comprises the R&D efforts of various sectors, including businesses, the federal government, nonfederal governments, higher education institutions, and nonprofit organizations. U.S. R&D performance totaled $667 billion in 2019 and an estimated $708 billion in 2020, compared to $407 billion in 2010. (All amounts are reported in current dollars, unless otherwise noted.) These most recent increases in the performance total ($50 billion or more each year in 2018 and 2019) are much larger than the average annual increases over the 2010–16 period ($19 billion each year). The main driver of these sizable increases is business R&D performance. Adjusted for inflation, average annual growth in the U.S. R&D total has outpaced average GDP growth for nearly two decades—3.8% compared to 2.2% average growth in GDP from 2010 to 2019, and 2.1% compared to 1.8% growth in GDP in the prior decade. As a result, the national R&D intensity has been on a rising path, from 2.79% in 2016 (a high point at the time) and 2.95% in 2018 to 3.12% in 2019 (the first time the U.S. exceeded 3.0%), and it is estimated to be 3.39% in 2020.

Globally, R&D expenditures have risen substantially since 2000 to an estimated $2.4 trillion in 2019—a more than threefold increase from $725 billion in 2000 (not adjusted for inflation). This expansion reflects the increasing importance of R&D in contributing to economic growth and competition as well as the significant role of R&D in addressing national and global challenges. Global R&D performance, however, is concentrated in a few countries. The United States leads the world's nations in R&D performance with a 28% global share in 2019, followed by China (22%). Together with Japan (7%), Germany (6%), South Korea (4%), France (3%), India (2%), and the United Kingdom (2%), these top eight R&D-performing countries account for about 75% of the global total R&D. Other countries with sizable R&D performance are (in decreasing order) Russia, Taiwan, Italy, Brazil, Canada, Spain, Turkey, the Netherlands, and Australia.

In this report, a larger gap is evident between the U.S. and China R&D totals than reported in earlier editions. *Science and Engineering Indicators 2020* puts China's R&D at 90% (and increasing) of the U.S. level in 2017. Updated data in this report show China's 2019 R&D total at 79% of the U.S. level, and the 2017 comparison has been revised downward to 76%. These changes resulted primarily from a comprehensive update, released in May 2020, of the purchasing power parity ratios used to convert a country's R&D expenditures to U.S. dollar expenditures as a common measure across all countries. These latest revisions had a more sizable effect on China than on other major R&D-performing countries.

Even so, the average annual rate of increase in China's R&D total (10.6% from 2010–19) continues to greatly exceed that of the United States (5.6%) and the European Union (EU-27) (5.6%). China's notable rise in R&D performance and the strong R&D performance by other Asian countries—Japan, South Korea, India, and Taiwan—are the drivers behind the sustained rise of R&D performance in East-Southeast and South Asia. The combined R&D performance across these Asian regions rose from 25% to 39% of the global total from 2000 to 2019, while the U.S. and EU-27 shares declined from 37% to 28% and from 22% to 18%, respectively. These broad trends in the global geography of R&D have been noted in earlier editions of this report and are reinforced by the latest data, indicating that the prospects for a further global shift remain strong.

In the United States, the business sector is the predominant force behind the R&D enterprise (75% of performance and 72% of funding of U.S. R&D in 2019). Since 2010, about 80% or more of the increase in the U.S. total R&D each year is attributable to businesses. Consequently, annual changes in business R&D greatly influence the overall U.S. R&D total. Business R&D performance is concentrated in five industries: chemicals manufacturing; computer and electronic products; transportation equipment; information services; and professional, scientific, and technical services. Businesses perform most of the R&D classified as experimental development (90% in 2019) and more than half of the applied research (58%). The business share of basic research has been increasing significantly in recent years (from 21% in 2010 to 32% in 2019).

The other sectors also make important contributions to the U.S. R&D enterprise but represent a fraction of the spending by the business sector. Higher education institutions and the federal government are the second- and third-largest performers of U.S. R&D. In 2019, higher education institutions performed 12% of the U.S. R&D total, over 60% of which was basic research. That same year, federal intramural R&D—through federal agencies and federally funded R&D centers—accounted for about 9% of the U.S. total R&D. Both, however, have experienced declines in their shares since 2010. (Higher education institutions performed 14%, and the federal government 13%, of U.S. total R&D in 2010.)

The federal government plays a larger role in R&D funding compared to performance and supports all sectors, particularly higher education institutions and federal intramural R&D. The federal government remains the largest source of support for the nation's basic research, although the share has dropped from 52% in 2010 to 41% in 2019. The federal government is also a sizable supporter of the nation's applied research—32% in 2019, compared to 56% of the support from the business sector. Despite its widespread role of funding, the share of federally funded R&D has been in decline for most of the past decade. In 2010, federal funding supported 31% of the total of U.S. R&D performance but dropped to 20% in 2019—and is estimated to drop further in 2020. This decline is, in part, a consequence of the large increases in R&D funding from the business sector in recent years, indicating that federal funding has not kept up with increases in other sectors.

Introduction

This report identifies the key current trends in the performance and funding of the U.S. research and experimental development (R&D) enterprise. The discussion covers the main sectors responsible for U.S. R&D: businesses, the federal government, nonfederal governments, higher education institutions, and nonprofit organizations. At numerous points, the report also directly contrasts these U.S. R&D indicators with broadly comparable data from the world's other major economies.

This report is organized into four major sections addressing the following topics: the recent trends (particularly over the last 5–10 years) in U.S. R&D performance and funding, both for the nation in total and across the major performing and funding sectors; comparisons of these U.S. R&D indicators to those of the world's other leading economies; a more detailed account of the U.S. business sector's large role in the nation's overall R&D activity; and further detail on the federal government's roles in conducting and funding U.S. R&D. For definitions of key terms used in this report, see the **Glossary** section.

An expanded account of the R&D performed by higher education institutions is provided by separate thematic reports in the *Indicators 2022* series: "[2022] Publications Output: U.S. Trends and International Comparisons" and "[2022] Academic Research and Development."

Recent Trends in U.S. R&D Performance

The U.S. R&D system consists of the activities of a diverse group of R&D performers and sources of funding. Included here are private businesses, the federal government, nonfederal governments, higher education institutions, and nonprofit organizations. The organizations that perform R&D often receive significant levels of outside funding, and organizations that fund R&D may also themselves be performers.

The principal sources of data for the indicators and analyses discussed in this section come from annual surveys of the R&D expenditures of these major performers and funders, conducted by the National Center for Science and Engineering Statistics (NCSES) within the National Science Foundation (NSF). A **Technical Appendix** to this report provides an overview of these surveys and the methods involved in collecting, compiling, and analyzing the data.[1]

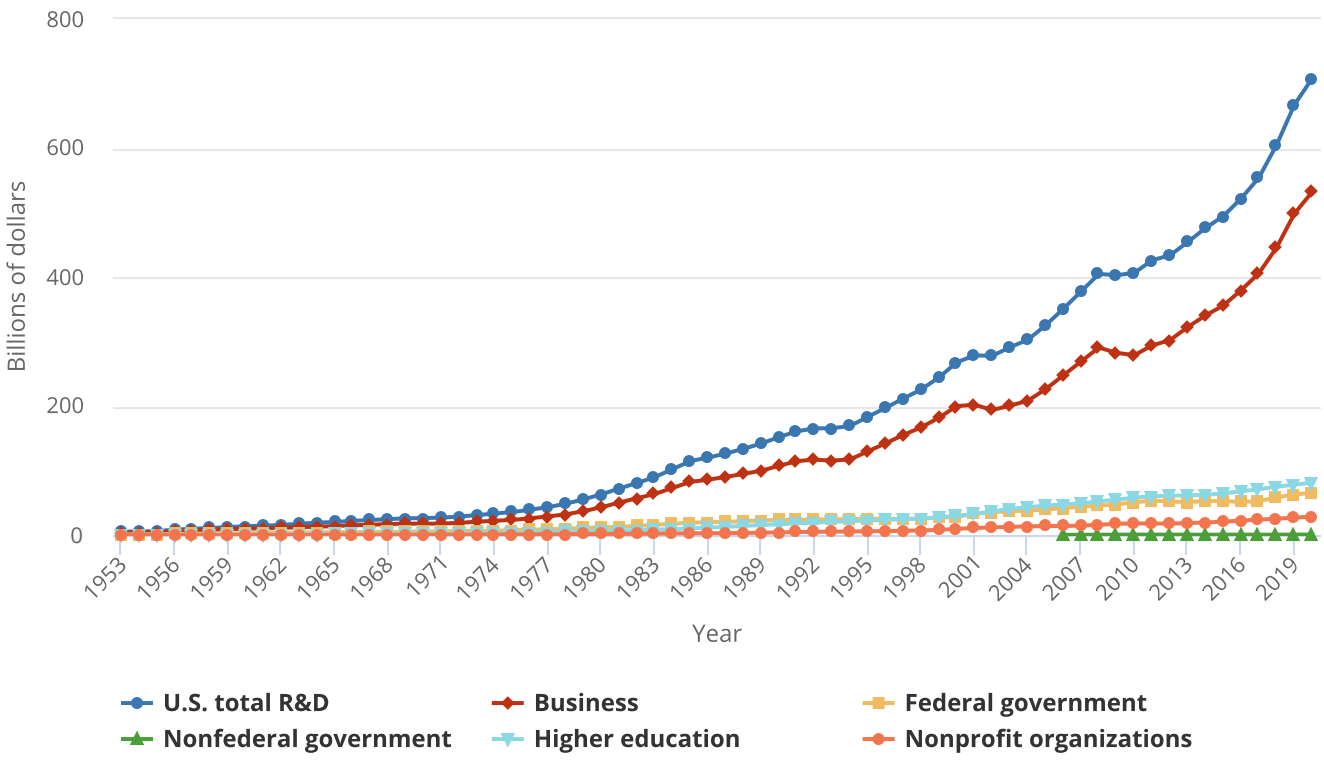
Current Trends in U.S. Total R&D and R&D Intensity

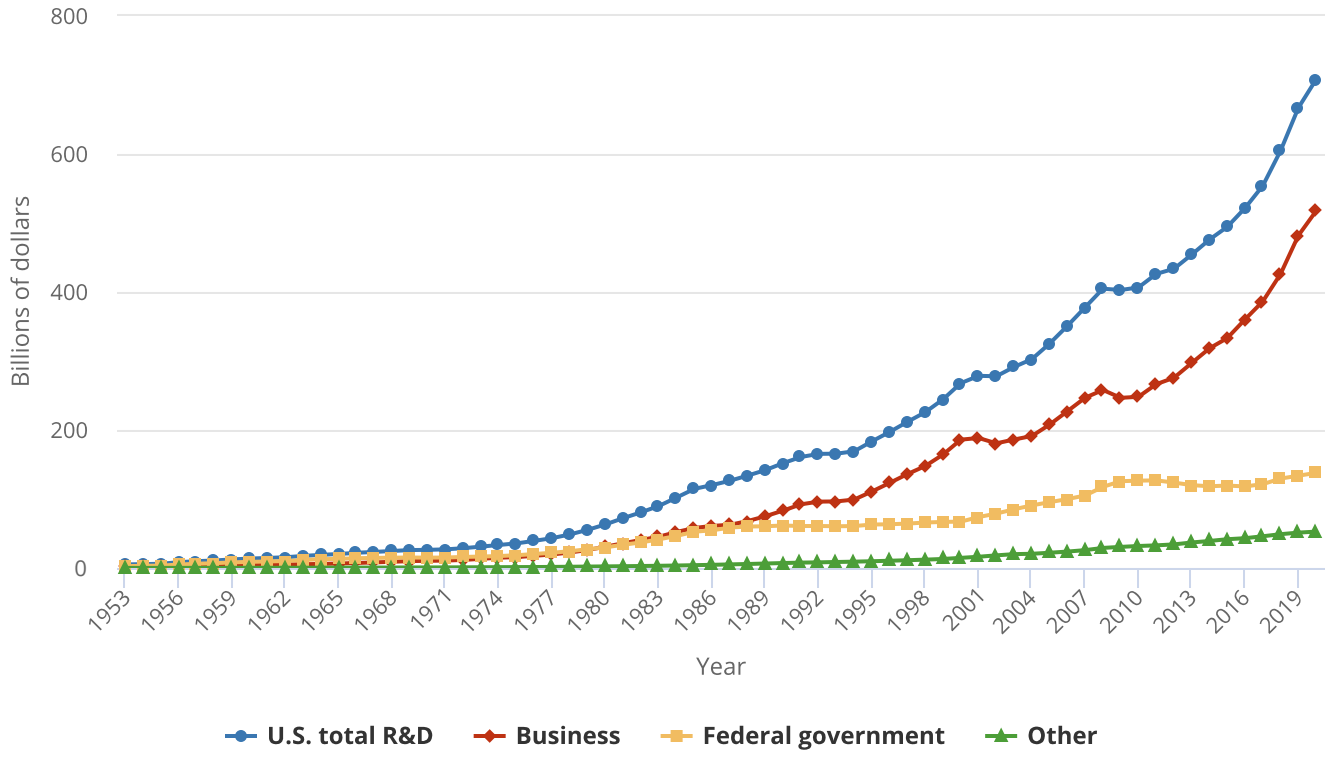
U.S. Total R&D

Research and experimental development (R&D) performed in the United States totaled $666.9 billion in 2019 (**Figure RD-1**; **Table RD-1**). The estimated total for 2020, based on performer-reported expectations, is $708.0 billion. These numbers compare with U.S. R&D totals of $494.5 billion in 2015 and $406.6 billion in 2010. (All amounts and calculations are reported in current dollars, unless otherwise noted.)

Figure RD-1

U.S. R&D, by performing sector and source of funds: 1953–2020





Note(s):
The data for 2020 include estimates and are likely to later be revised. Federal performers of R&D include federal agencies and federally funded research and development centers. Nonfederal government R&D performance is that of state governments. (Data in this series were not available prior to 2006.) R&D funding listed as other is from higher education institutions, nonfederal governments (state and local), and nonprofit organizations.

Source(s):
National Center for Science and Engineering Statistics, National Patterns of R&D Resources (2019–20 edition).

Science and Engineering Indicators

Table RD-1

U.S. R&D expenditures, by performing sector and source of funds: 2010–20

(Millions of current and constant 2012 dollars)

Sector	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020[a]
Millions of current dollars											
All performing sectors	406,600	426,215	433,716	454,271	475,969	494,499	521,700	554,012	604,837	666,875	707,967
Business	278,977	294,092	302,251	322,528	340,728	355,821	379,529	405,792	445,563	498,175	531,941
Federal government	50,798	53,524	52,144	51,086	52,687	52,847	51,187	52,553	58,356	62,802	65,685
Federal intramural[b]	31,970	34,950	34,017	33,406	34,783	34,199	31,762	32,231	36,793	39,870	41,936
FFRDCs	18,828	18,574	18,128	17,680	17,903	18,649	19,424	20,322	21,563	22,932	23,749
Nonfederal government	691	694	665	620	583	595	620	632	643	675	696
Higher education	58,084	60,088	60,895	61,548	62,351	64,635	67,792	71,115	74,914	78,176	81,111
Nonprofit organizations[c]	18,050	17,817	17,762	18,489	19,620	20,601	22,573	23,921	25,361	27,048	28,533
All funding sources	406,600	426,215	433,716	454,271	475,969	494,499	521,700	554,012	604,837	666,875	707,967
Business	248,126	266,427	275,728	297,188	318,410	333,243	360,291	386,385	426,193	481,799	517,431
Federal government	126,617	127,014	123,837	120,132	118,367	119,532	118,174	121,632	129,625	133,807	137,818
Nonfederal government	4,303	4,387	4,158	4,243	4,213	4,277	4,520	4,578	4,731	4,929	5,038
Higher education	12,262	13,103	14,300	15,378	16,210	17,292	18,415	19,555	20,682	21,562	22,607

Table RD-1

U.S. R&D expenditures, by performing sector and source of funds: 2010–20

(Millions of current and constant 2012 dollars)

Sector	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020[a]
Nonprofit organizations[c]	15,292	15,284	15,694	17,330	18,768	20,156	20,300	21,862	23,607	24,778	25,073
Millions of constant 2012 dollars											
All performing sectors	422,811	434,187	433,716	446,452	459,193	472,344	493,381	514,181	548,252	593,865	622,951
Business	290,100	299,593	302,251	316,977	328,719	339,879	358,928	376,617	403,879	443,634	468,063
Federal government	52,824	54,525	52,144	50,207	50,830	50,480	48,408	48,774	52,897	55,926	57,797
Federal intramural[b]	33,245	35,604	34,017	32,831	33,557	32,666	30,038	29,914	33,351	35,505	36,900
FFRDCs	19,579	18,921	18,128	17,376	17,272	17,813	18,370	18,861	19,546	20,421	20,897
Nonfederal government	719	707	665	609	563	568	586	587	583	601	613
Higher education	60,400	61,211	60,895	60,488	60,153	61,739	64,112	66,002	67,906	69,617	71,371
Nonprofit organizations[c]	18,769	18,150	17,762	18,171	18,928	19,678	21,347	22,201	22,988	24,086	25,107
All funding sources	422,811	434,187	433,716	446,452	459,193	472,344	493,381	514,181	548,252	593,865	622,951
Business	258,019	271,411	275,728	292,073	307,187	318,312	340,734	358,605	386,321	429,051	455,296
Federal government	131,665	129,390	123,837	118,064	114,195	114,177	111,759	112,887	117,498	119,157	121,268
Nonfederal government	4,475	4,469	4,158	4,170	4,065	4,085	4,275	4,249	4,288	4,389	4,433
Higher education	12,750	13,348	14,300	15,113	15,639	16,517	17,415	18,149	18,747	19,202	19,893
Nonprofit organizations[c]	15,902	15,570	15,694	17,031	18,107	19,253	19,198	20,290	21,398	22,065	22,062

FFRDC = federally funded research and development center.

[a] The data for 2020 are estimates and are likely later to be revised.

[b] Includes expenditures of federal intramural R&D as well as costs associated with administering extramural R&D procurements.

[c] Some components of the R&D performed by nonprofit organizations are estimated and may later be revised.

Note(s):
Data are based on annual reports by performers, except for the nonprofit sector. Expenditure levels for higher education, federal government, and nonfederal government performers are calendar year approximations based on fiscal year data.

Source(s):
National Center for Science and Engineering Statistics, National Patterns of R&D Resources (2019–20 edition).

Science and Engineering Indicators

Year-over-year increases in the total of U.S. R&D expenditures averaged $19.2 billion over the 2010–16 period (calculated from the data in **Table RD-1**). This level of annual increase was, in general, a sufficient pace to remain well ahead of the rate of expansion of the nation's gross domestic product (GDP) (**Table RD-2**). Nonetheless, an even stronger pace of R&D increase has emerged in the years since. The U.S. R&D total in 2017 was $32.3 billion ahead of the previous year; $50.8 billion in 2018; and $62.0 billion in 2019—and, as presently estimated, $41.1 billion in 2020 (**Figure RD-2**). This pattern of sustained annual increase in the U.S. total R&D since 2010 has been due mainly to consistently higher levels of business R&D performance, which have been near 80% or more of the total annual increases since 2010 (**Figure RD-2**).

Table RD-2

Annual rates of change in U.S. R&D expenditures, by performing sector: 1990–2020

(Percent)

Expenditures and gross domestic product	Longer-term trends			Most recent years									
	1990–2000	2000–10	2010–19	2010–11	2011–12	2012–13	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20[a]
Current dollars													
Total R&D, all performers	5.8	4.3	5.7	4.8	1.8	4.7	4.8	3.9	5.5	6.2	9.2	10.3	6.2

Table RD-2

Annual rates of change in U.S. R&D expenditures, by performing sector: 1990–2020

(Percent)

Expenditures and gross domestic product	Longer-term trends			Most recent years									
	1990–2000	2000–10	2010–19	2010–11	2011–12	2012–13	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20[a]
Business	6.4	3.4	6.7	5.4	2.8	6.7	5.6	4.4	6.7	6.9	9.8	11.8	6.8
Federal government	1.9	5.9	2.4	5.4	-2.6	-2.0	3.1	0.3	-3.1	2.7	11.0	7.6	4.6
Federal intramural	2.1	5.2	2.5	9.3	-2.7	-1.8	4.1	-1.7	-7.1	1.5	14.2	8.4	5.2
FFRDCs	1.7	7.3	2.2	-1.4	-2.4	-2.5	1.3	4.2	4.2	4.6	6.1	6.3	3.6
Nonfederal government[b]	NA	NA	-0.3	0.4	-4.2	-6.8	-5.9	2.0	4.3	1.9	1.7	5.0	3.1
Higher education	5.9	6.9	3.4	3.4	1.3	1.1	1.3	3.7	4.9	4.9	5.3	4.4	3.8
Nonprofit organizations[c]	8.8	6.6	4.6	-1.3	-0.3	4.1	6.1	5.0	9.6	6.0	6.0	6.7	5.5
Gross domestic product	5.6	3.9	4.0	3.7	4.2	3.6	4.2	3.7	2.7	4.2	5.4	4.1	-2.2
Constant 2012 dollars													
Total R&D, all performers	3.7	2.1	3.8	2.7	-0.1	2.9	2.9	2.9	4.5	4.2	6.6	8.3	4.9
Business	4.3	1.2	4.8	3.3	0.9	4.9	3.7	3.4	5.6	4.9	7.2	9.8	5.5
Federal government	-0.1	3.8	0.6	3.2	-4.4	-3.7	1.2	-0.7	-4.1	0.8	8.5	5.7	3.3
Federal intramural	0.0	3.0	0.7	7.1	-4.5	-3.5	2.2	-2.7	-8.0	-0.4	11.5	6.5	3.9
FFRDCs	-0.4	5.1	0.5	-3.4	-4.2	-4.1	-0.6	3.1	3.1	2.7	3.6	4.5	2.3
Nonfederal government[b]	NA	NA	-2.0	-1.7	-5.9	-8.4	-7.6	0.9	3.3	0.0	-0.7	3.2	1.9
Higher education	3.7	4.6	1.6	1.3	-0.5	-0.7	-0.6	2.6	3.8	2.9	2.9	2.5	2.5
Nonprofit organizations[c]	6.6	4.4	2.8	-3.3	-2.1	2.3	4.2	4.0	8.5	4.0	3.5	4.8	4.2
Gross domestic product	3.4	1.8	2.2	1.5	2.3	1.8	2.3	2.7	1.7	2.3	2.9	2.3	-3.4

NA = not available.

FFRDC = federally funded research and development center.

[a] The R&D data for 2020 include estimates and are likely to be later revised.

[b] Survey data on state intramural R&D performance were not available prior to 2006.

[c] Some components of the R&D performed by nonprofit organizations are estimated and may later be revised.

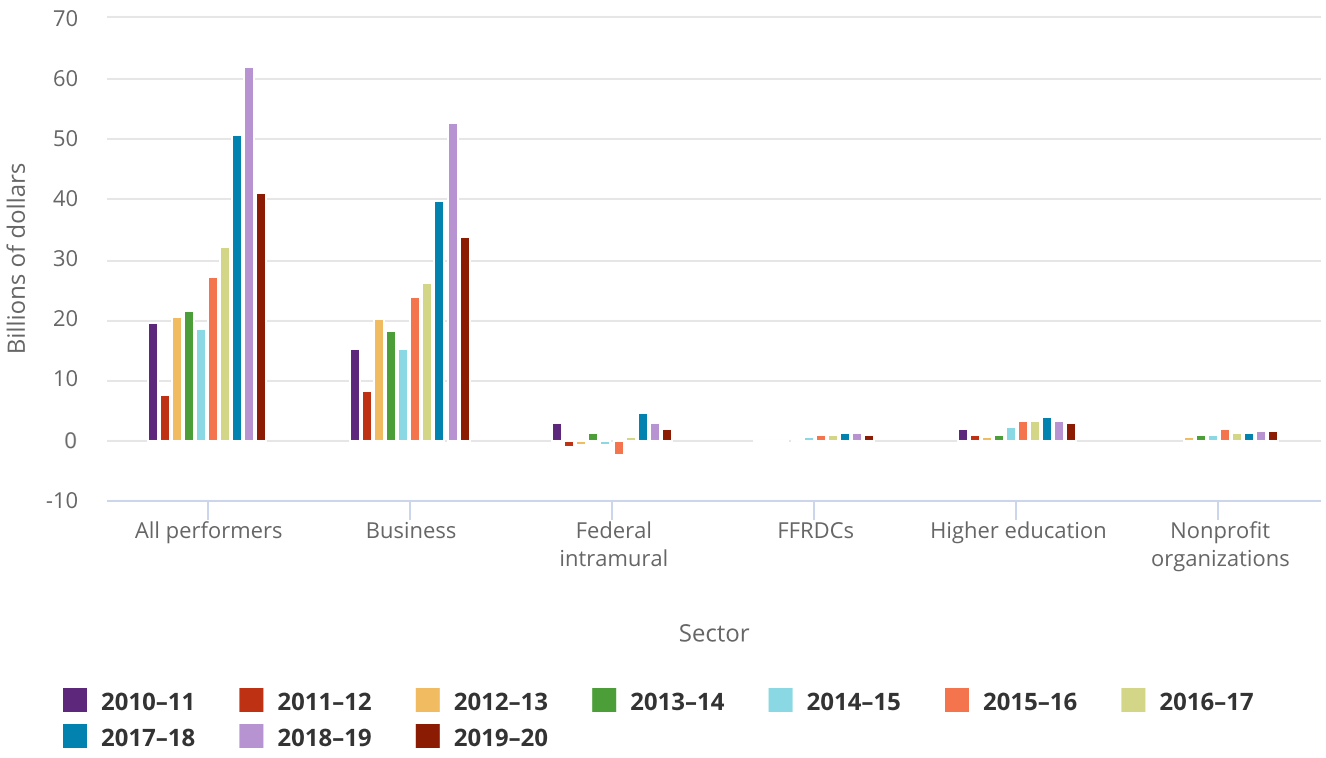
Note(s):
The longer-term trend rates are calculated as compound annual growth rates.

Source(s):
National Center for Science and Engineering Statistics, National Patterns of R&D Resources (2019–20 edition).

Science and Engineering Indicators

Figure RD-2

Year-to-year changes in U.S. R&D expenditures, by performing sector: 2010–20



FFRDC = federally funded research and development center.

Note(s):
Data are calculated from R&D expenditure data reported for performers in Table RD-1. The data for 2020 include estimates and are likely to later be revised. Expenditures by nonfederal government performers are comparatively negligible, and specific bars for this sector are excluded.

Source(s):
National Center for Science and Engineering Statistics, National Patterns of R&D Resources (2019–20 edition).

Science and Engineering Indicators

Adjusting for inflation, growth in U.S. total R&D averaged 3.8% annually over the 2010–19 period, well above the 2.2% average growth of U.S. gross domestic product (GDP) over the same period (**Table RD-2**).[2] The average annual growth of U.S. total R&D in the prior decade (2000–10) was lower at 2.1%, compared to 1.8% rate of GDP expansion.[3] The estimate for 2020 shows R&D growing at 4.9%, compared to a 3.4% decline in GDP.

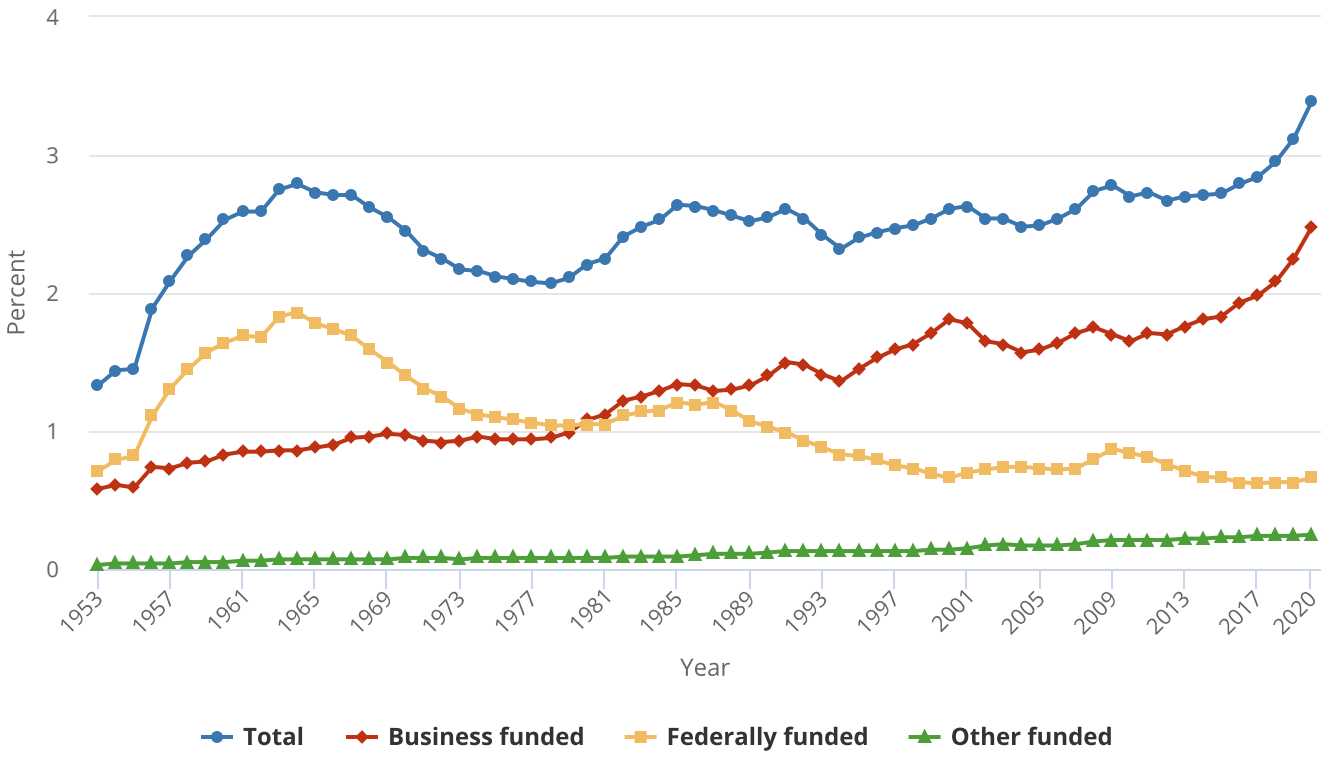
U.S. National R&D Intensity

The ratio of total national R&D expenditures to GDP is widely used by national statistical offices and policy analysts as an overall gauge of the intensity of a nation's R&D effort. In this new edition of the data, the ratio of U.S. R&D to GDP was 3.12% in 2019, and it is estimated to be 3.39% in 2020.

The U.S. ratio generally has been rising since the mid-1990s, although with some periods of decline (**Figure RD-3**). The highest U.S. ratios recorded in the past have been 2.79% in 1964, 2.78% in 2009, 2.79% again in 2016, 2.84% in 2017, and 2.95% in 2018.[4] Reaching an R&D intensity level above 3.0% is widely regarded in the R&D policy community as a notable national achievement. Some further maturity in the data is warranted in interpreting the reported 3.39% for 2020—both due to its estimated nature and the fact that the sizable uptick from 2019 reflects both a rising R&D level but also a declining GDP.

Figure RD-3

Ratio of U.S. R&D to gross domestic product, by roles of federal, business, and other funding for R&D: 1953–2020



Note(s):
The data for 2020 include estimates and are likely to later be revised. The federally funded data represent the federal government as a funder of R&D by all performers; similarly, the business funded data cover the business sector as a funder of R&D by all performers. The other funded category includes the R&D funded by all other sources—mainly, by higher education, nonfederal government, and nonprofit organizations. The gross domestic product data used reflect the U.S. Bureau of Economic Analysis statistics of late October 2021.

Source(s):
National Center for Science and Engineering Statistics, National Patterns of R&D Resources (2019–20 edition).

Science and Engineering Indicators

Most of the rise in the R&D-to-GDP ratio over the past several decades has been the result of the increase in nonfederal spending on R&D, particularly by the business sector. This arises largely from the growing role of business R&D in the national R&D system, which in turn reflects the increase of R&D-dependent goods and services in the national and global economies. By contrast, the share of federally funded R&D expenditures declined from the mid-1980s to the late 1990s, notably from cuts in defense-related R&D. This was followed by a gradual uptick through 2009, driven by increased federal spending on biomedical and national security R&D and the one-time incremental funding for R&D provided by the American Recovery and Reinvestment Act of 2009 (ARRA). The federally funded share, however, has returned to a path of mainly decline since 2010 (**Figure RD-3**).

Performers of R&D

Business Sector

The business sector is by far the largest performer of U.S. R&D. In 2019, domestically performed business R&D accounted for $498.2 billion, or 75% of the $666.9 billion national R&D total (**Table RD-1** and **Table RD-3**).[5] The business sector's status as the predominant player in national R&D performance has long been the case, with its annual share ranging between 69% and 75% over the two-decade period of 2000–19 (**Figure RD-1**).

Table RD-3

U.S. R&D expenditures, by performing sector, source of funds, and type of R&D: 2019

(Millions of dollars)

Performing sector and type of R&D	Total	Business	Federal government	Nonfederal government	Higher education	Nonprofit organizations	Percent by performer
R&D	666,875	481,799	133,807	4,929	21,562	24,778	100.0
Business	498,175	474,442	22,653	169	**	911	74.7
Federal government	62,802	179	62,408	49	**	166	9.4
Federal intramural	39,870	0	39,870	0	0	0	6.0
FFRDCs	22,932	179	22,538	49	**	166	3.4
Nonfederal government	675	23	290	347	4	12	0.1
Higher education	78,176	4,808	39,556	4,364	21,559	7,889	11.7
Nonprofit organizations	27,048	2,347	8,900	***	***	15,800	4.1
Percent by funding source	100.0	72.2	20.1	0.7	3.2	3.7	-
Basic research	102,874	33,745	42,199	2,618	13,594	10,719	100.0
Business	32,582	30,132	2,349	15	**	86	31.7
Federal government	11,932	36	11,853	10	**	33	11.6
Federal intramural	7,352	0	7,352	0	0	0	7.1
FFRDCs	4,580	36	4,501	10	**	33	4.5
Nonfederal government	120	4	52	62	1	2	0.1
Higher education	49,126	2,729	25,358	2,531	13,594	4,916	47.8
Nonprofit organizations	9,113	844	2,588	***	***	5,681	8.9
Percent by funding source	100.0	32.8	41.0	2.5	13.2	10.4	-
Applied research	132,021	73,277	41,849	1,675	5,766	9,454	100.0
Business	76,176	70,679	5,246	42	**	209	57.7
Federal government	20,522	83	20,339	23	**	77	15.5
Federal intramural	11,264	0	11,264	0	0	0	8.5
FFRDCs	9,258	83	9,075	23	**	77	7.0
Nonfederal government	524	18	225	269	3	9	0.4
Higher education	21,793	1,449	11,144	1,341	5,763	2,097	16.5
Nonprofit organizations	13,006	1,049	4,895	***	***	7,062	9.9
Percent by funding source	100.0	55.5	31.7	1.3	4.4	7.2	-
Experimental development	431,980	374,777	49,758	636	2,202	4,607	100.0
Business	389,418	373,631	15,058	112	**	617	90.1
Federal government	30,347	60	30,215	17	**	56	7.0
Federal intramural	21,253	0	21,253	0	0	0	4.9
FFRDCs	9,093	60	8,962	17	**	56	2.1
Nonfederal government	31	1	13	16	*	1	0.0
Higher education	7,257	631	3,055	492	2,202	877	1.7
Nonprofit organizations	4,928	454	1,417	***	***	3,057	1.1
Percent by funding source	100.0	86.8	11.5	0.1	0.5	1.1	-

* = amount < $0.5 million; ** = small to negligible amount, included as part of the funding provided by nonprofit organizations; *** = small to negligible amount, included as part of the funding provided by other sectors.

FFRDC = federally funded research and development center.

Note(s):
Some components of R&D performance and funding by nonprofit organizations are estimated and may later be revised.

Source(s):
National Center for Science and Engineering Statistics, National Patterns of R&D Resources (2019–20 edition).

Science and Engineering Indicators

Adjusted for inflation, growth in business R&D averaged 4.8% annually over the period 2010–19, well ahead of the 3.8% annual average for U.S. total R&D and the 2.2% annual average for GDP (**Table RD-2**).

Higher Education

R&D performed in the United States by the higher education sector totaled $78.2 billion in 2019, or 12% of U.S. total R&D (**Table RD-1** and **Table RD-3**). Over the period 2000–19, the higher education share of U.S. R&D has ranged between 11% and 14%.[6]

Adjusted for inflation, growth in this sector's R&D performance averaged 1.6% annually over 2010–19, well behind both U.S. total R&D (3.8%) and GDP (2.2%) (**Table RD-2**). The year-by-year trajectory in higher education R&D expenditures has been marked by contrasts: relatively low growth in 2010 and 2011, a noticeable slowdown in 2012–14, and then higher but still comparatively modest rates (similar to those for GDP) in 2015–19.

Federal Agencies and Federally Funded Research and Development Centers

The federal government performed $62.8 billion, or 9% of U.S. R&D in 2019 (**Table RD-1** and **Table RD-3**). This included $39.9 billion (6% of the U.S. total) performed by the intramural R&D facilities of federal agencies and $22.9 billion (3%) of R&D performed by the 42 federally funded research and development centers (FFRDCs).[7] The federal share of U.S. R&D performance rose from about 11% in 2000 to 12% in 2010 but has declined since then, down to about 9% in 2019.

Adjusted for inflation, this sector's R&D performance over 2010–19 has increased at an annual rate of 0.6%—in contrast to the 3.8% rate for total U.S. R&D and 2.2% for GDP (**Table RD-2**). In the previous decade (2000–10), federal R&D performance grew an average of 3.8% yearly, well ahead of U.S. total R&D (2.1%). However, the year-over-year changes for 2010–19 are a varied picture, with outright declines or low growth rates for 2012–17 but a turn to markedly higher rates of increase in 2018–19. Part of this history reflects the waning after 2010 of the incremental funding from ARRA and the more challenging environment for federal budget support after 2011; in 2018 and 2019, the results of lengthy congressional debates on federal spending resulted in substantial increases to federal funding for R&D.[8]

State Government

State agency intramural R&D performance in 2019 totaled $675 million—a small share (about 0.1%) of the U.S. total (**Table RD-1** and **Table RD-3**). This includes all 50 states and the District of Columbia.

Nonprofit Organizations

R&D performed in the United States by nonprofit organizations (excluding higher education institutions, the federal government, and nonfederal governments) was an estimated $27.0 billion in 2019 (**Table RD-1** and **Table RD-3**). This was 4% of U.S. total R&D, a share that has changed little since the early 2000s.

Sources of R&D Funding

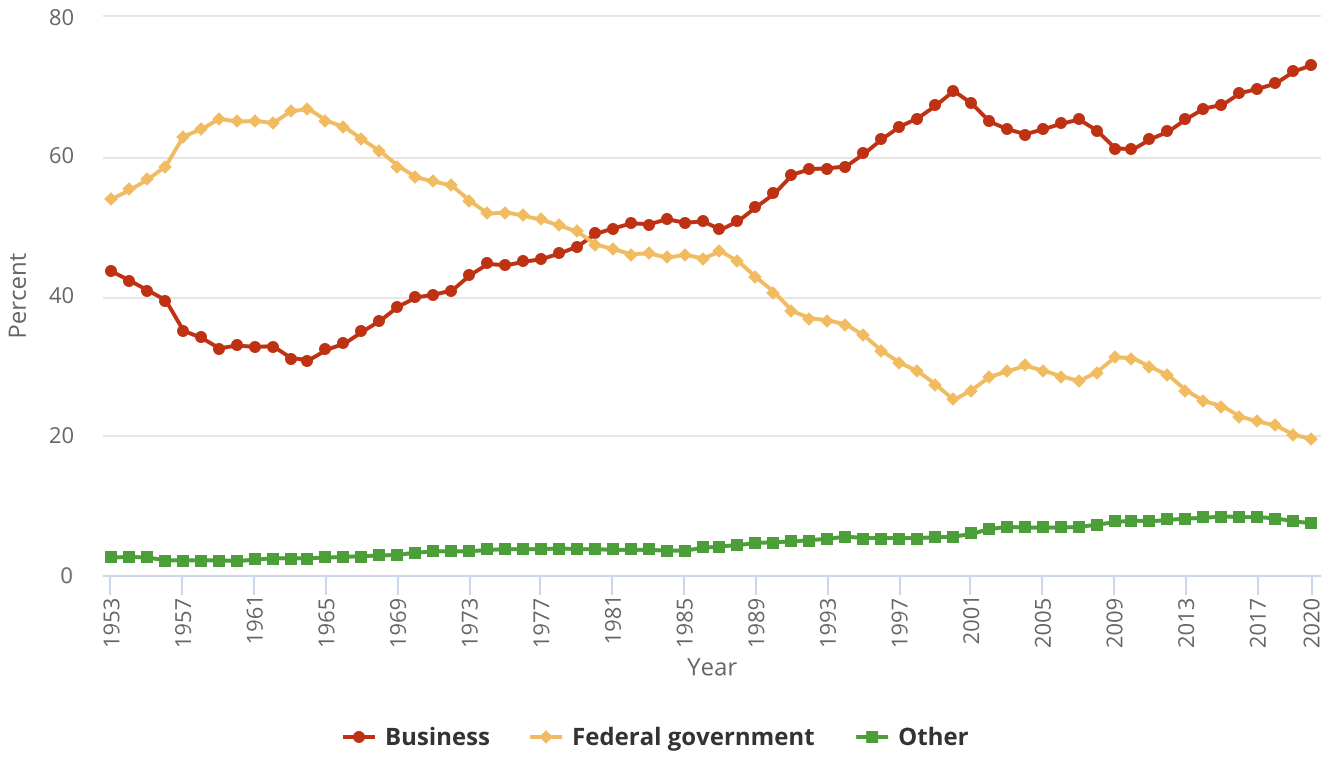
R&D Funding by Business

Matching its predominant role in R&D performance, the business sector is also the leading source of funding for R&D performed in the United States. In 2019, business sector's funding accounted for $481.8 billion, or 72% of the total U.S. R&D performance (**Table RD-3**). Nearly all (98%) of the business sector's funding for R&D that year supported business R&D performance—whether performed by the company itself or in support of the R&D performed by other companies.[9] Most of the remainder went to R&D performers in higher education and nonprofit organizations, along with small amounts to FFRDCs and nonfederal governments.

The business sector's dominant role in the nation's R&D funding began in the early 1980s, when its support started to exceed 50% of all U.S. R&D funding (**Figure RD-4**). Over 2000–19, the business sector's share of the U.S. R&D funding total has ranged from 61% to 72% yearly.

Figure RD-4

U.S. total R&D expenditures, by source of funds: 1953–2020



Note(s):
The data for 2020 include estimates and are likely to later be revised. The other category includes nonfederal government, higher education institutions, and nonprofit organizations.

Source(s):
National Center for Science and Engineering Statistics, National Patterns of R&D Resources (2019–20 edition).

Science and Engineering Indicators

R&D Funding by the Federal Government

The federal government is the second-largest source of funding for U.S. R&D, behind the business sector. It is a significant resource for most of the U.S. R&D performer sectors, except the business sector, in which the federal role, while far from negligible, is overshadowed by businesses funding business R&D.

Funds from the federal government accounted for $133.8 billion, or 20% of U.S. total R&D in 2019 (**Table RD-1**). The largest amounts of federal funding were directed to R&D performance by the federal government, higher education, and businesses (**Table RD-3**). In 2019, federal funding supported about 51% of academic R&D performance, 5% of business R&D performance, 33% of nonprofit R&D performance, all of federal intramural R&D performance, and almost all (98%) of FFRDC R&D performance.

Several decades ago, the federal government was the leading sponsor of the nation's R&D—funding 67% of all U.S. R&D in 1964 (**Figure RD-4**). The federal share decreased to half (49%) of all funding in the late 1970s, to a little over a third (36%) in the mid-1990s, and to a quarter (25%) by the turn of the century. (A major factor in the decrease of the federal share of national R&D was the sharp decline in funding for space R&D after the United States won the race to the moon in the late 1960s. At largely the same time, the business sector was rapidly expanding its energy-related R&D in response to the world oil supply crises. For additional detail on this history, see Jankowski [2001, 2013].) The share ticked up again to 31% in 2009 and 2010, amid changing business conditions and expanded federal funding for health, defense, and counterterrorism R&D (including ARRA funding). The federal share, however, again declined in subsequent years and stood at 20% in 2019. Some of this recent year's decline reflects the waning of the ARRA incremental funding and the more challenging federal budget environment since 2011. Another reason for the decline, however, is a natural consequence of the large increases in R&D funding from the business sector that also have been happening in these recent years.

R&D Funding from Other Sources

The remainder of R&D funding from other sources is a smaller component: $51.3 billion in 2019, or about 8% of all U.S. R&D performance (**Table RD-3**). Of this amount, $21.6 billion was from higher education's own institutional funds, nearly all of which remain in the academic sector; $4.9 billion was from state and local governments, primarily supporting academic research; and $24.8 billion was from nonprofit organizations, mostly funding this sector's own R&D. Of the estimated nonprofit total, some funds ($7.9 billion) support R&D in higher education, and small amounts supported that of businesses ($0.9 billion), FFRDCs ($0.2 billion), and state government ($0.1 billion).

R&D by Type of R&D

In 2019, basic research activities comprised $102.9 billion (15%) of total U.S. R&D expenditures, followed by applied research at $132.0 billion (20%) and $432.0 billion (65%) for experimental development (**Table RD-3** and **Table RD-4**). (For definitions of these terms, see the **Glossary** section.)[10]

Table RD-4

U.S. R&D expenditures, by type of R&D: Selected years, 2000–20

(Billions of current dollars, constant 2012 dollars, and percent distribution)

Type of R&D	2000	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020[a]
Billions of current dollars											
All R&D	267.9	406.6	433.7	454.3	476.0	494.5	521.7	554.0	604.8	666.9	708.0
Basic research	42.0	76.3	73.8	79.1	82.8	84.3	85.7	88.7	96.0	102.9	107.9
Applied research	56.5	79.1	86.8	88.2	91.8	97.2	110.5	114.1	119.8	132.0	139.5
Development	169.4	251.2	273.1	287.0	301.4	313.0	325.5	351.2	389.0	432.0	460.5
Billions of constant 2012 dollars											

Table RD-4

U.S. R&D expenditures, by type of R&D: Selected years, 2000–20

(Billions of current dollars, constant 2012 dollars, and percent distribution)

Type of R&D	2000	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020[a]
All R&D	343.2	423.1	433.7	446.5	459.2	472.3	493.4	514.2	548.3	593.9	623.0
Basic research	53.8	79.4	73.8	77.8	79.9	80.5	81.0	82.3	87.1	91.6	94.9
Applied research	72.4	82.3	86.8	86.6	88.5	92.9	104.5	105.9	108.6	117.6	122.8
Development	217.0	261.4	273.1	282.0	290.8	299.0	307.9	326.0	352.6	384.7	405.2
Percent distribution											
All R&D	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Basic research	15.7	18.8	17.0	17.4	17.4	17.0	16.4	16.0	15.9	15.4	15.2
Applied research	21.1	19.4	20.0	19.4	19.3	19.7	21.2	20.6	19.8	19.8	19.7
Development	63.2	61.8	63.0	63.2	63.3	63.3	62.4	63.4	64.3	64.8	65.1

[a] The data for 2020 include estimates and are likely to later be revised.

Note(s):
Data throughout the time series reported here are consistently based on the Organisation for Economic Co-operation and Development's *Frascati Manual* (OECD 2015) definitions for basic research, applied research, and experimental development. Prior to 2010, however, some changes were introduced in the questionnaires of the sectoral expenditure surveys to improve the accuracy of respondents' classification of their R&D by type. Accordingly, small percentage changes in the historical data may not be meaningful.

Source(s):
National Center for Science and Engineering Statistics, National Patterns of R&D Resources (2019–20 edition).

Science and Engineering Indicators

Basic Research

Higher education institutions continued to be the largest performer of U.S. basic research in 2019, while the federal government remained the largest source of funding for basic research. Higher education performed just under half (48%) of all basic research, and the federal government funded about 41% of all basic research performed (**Table RD-3**). The business sector was also a substantial performer (32%) and funder (33%) of basic research. The federal government (agency intramural laboratories and FFRDCs) and nonprofit organizations were smaller performers, accounting for 12% and 9%, respectively, of the U.S basic research performance total in 2019.

Applied Research

The business sector was both the largest performer (58%) and largest funder (56%) of applied research in 2019 (**Table RD-3**). Higher education (17%), the federal government (16%), and nonprofit organizations (10%) were the next-largest performers of applied research.

The vast majority of business sector's funding for applied research remained within the sector (**Table RD-3**). The federal government provided about a third of applied research funding, with its funding spread broadly across different sectors; higher education and federal intramural laboratories and FFRDCs received the largest amounts.

Experimental Development

The business sector predominates in experimental development, performing 90% of the R&D in this category in 2019 (**Table RD-3**).[11] The federal government accounted for another 7%, much of it defense related, with the federal government itself the primary user of the results. By contrast, higher education and nonprofit organizations perform relatively little development (2% and 1%, respectively, of the total in 2019).

The business sector provided 87% of the funding for the experimental development performed in 2019, nearly all of which remained in that sector (**Table RD-3**). Federal funding accounted for about 12% of the experimental development total, with the business sector (especially defense-related industries) and federal intramural laboratories as the largest recipients.

Trend in Shares, by Type of R&D

Over the 2010–19 period, the split of U.S. total R&D expenditures among the three types of R&D has not largely changed. Applied research has tracked in the range of 19%–21% throughout the period (**Table RD-4**). However, there is the appearance of a gradual drop in the share of basic research, from 19% in 2010 to 15% in 2019. The opposite was the case for experimental development, which rose from 62% in 2010 to 65% in 2019. Nonetheless, adjusting for inflation, about $12 billion more basic research was performed in 2019 than in 2010, $35 billion more applied research, and $123 billion more experimental development.

Interesting shifts in the relative roles of performers and funders continue to be seen in the realm of basic research. In 2010, businesses performed 21% of U.S. basic research, but the sector's role rose to 32% in 2019—due in large part to substantial increases in basic research performed by the pharmaceuticals and medicines industries as well as the information industry and the professional, scientific, and technical services industry. Over the same period, the share of U.S. basic research performed by higher education institutions—historically, the nation's largest basic research performer—declined from 51% in 2010 to 48% in 2019. Further, businesses funded 23% of U.S. basic research in 2010, rising to 33% in 2019. Over the same period, the federally funded share declined from 52% in 2010 to 41% in 2019.[12]

(While these key features of the data are noteworthy, care is needed in definitively identifying trends. Various methodological improvements in the R&D performer surveys—but no material revisions in the type-of-R&D definitions—have been made over time, particularly before 2010, with the net implication that small percentage changes in the reported shares may not be meaningful.)[13]

Cross-National Comparisons of R&D Performance

Two key indicators of national R&D performance are gross domestic expenditures on R&D (GERD)—a measure of a country's total R&D investment—and national R&D intensity (GERD-to-GDP ratio)—a measure of a country's investment in R&D relative to its overall economic activity. Together, they paint a broad picture of the current distribution of global R&D activities and the changing global R&D landscape as countries build capabilities in science and technology to improve their national economy and society.

This section compares R&D performance in the United States with other major R&D-performing nations globally, including China, Japan, South Korea, France, Germany, India, and the United Kingdom as well as key regional and geopolitical groupings, such as the European Union (EU-27) and East-Southeast and South Asia. It also presents cross-national analyses of trends in the composition of R&D by sector and by R&D type.

The national R&D expenditures presented in this report are from the Organisation for Economic Co-operation and Development's (OECD) Main Science and Technology Indicators and the United Nations Educational, Scientific and Cultural Organization's (UNESCO) Institute for Statistics. The global R&D total is estimated by NCSES based on these sources and reflects R&D performance by 119 countries with reported annual R&D expenditures of $50 million or more.[14] These countries account for most of the current global R&D.

R&D expenditures for all countries are reported in current U.S. dollars (not adjusted for inflation) using purchasing power parities (PPPs). PPPs convert different currencies to a common currency while adjusting for differences in price levels between economies. The use of PPPs thus enables direct comparisons of R&D expenditures across countries. (See the **Technical Appendix** for more details.)

The regional analysis focuses on the regions with the largest R&D expenditures: North America (United States, Canada, and Mexico), Europe (including the EU-27 member countries), and the portion of Asia that includes the regions of East-Southeast Asia (including China, Japan, South Korea, and Taiwan), and South Asia (including India and Pakistan). The groupings of countries into regions are from *The World Factbook* (CIA 2021).

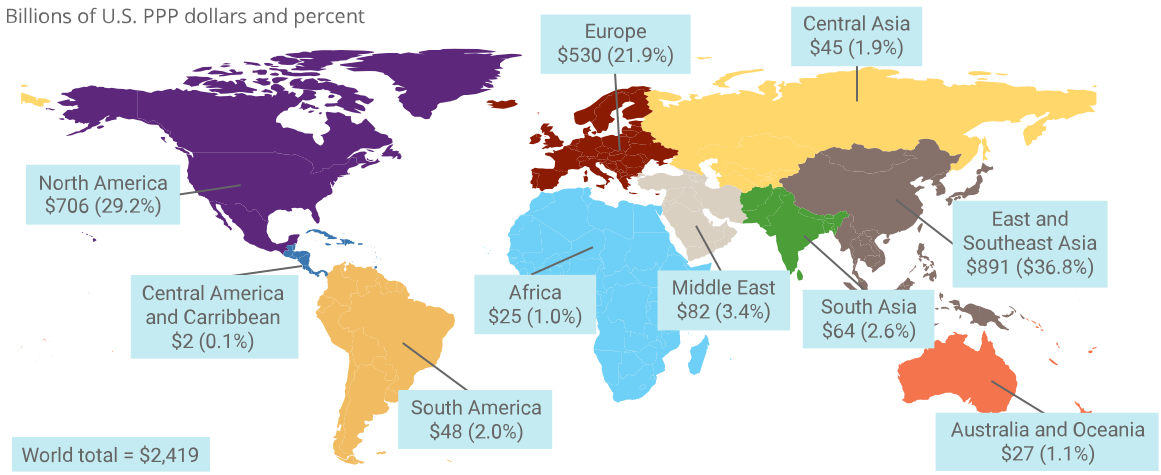
Patterns and Trends in Total National R&D

Country and Regional Patterns in Total National R&D, 2019

The estimated total for global R&D expenditures in 2019 is just over $2.4 trillion (**Figure RD-5**). Global R&D performance is concentrated in the following geographic regions: East-Southeast and South Asia (combined R&D expenditures of $955.0 billion, or a 39% share of global R&D), North America ($706.1 billion, or 29%), and Europe ($529.6 billion, or 22%). All other regions combined account for 10% of global R&D performance.

Figure RD-5

Global R&D expenditures, by region: 2019



PPP = purchasing power parity.

Note(s):
Foreign currencies are converted to dollars through PPPs. Some country data are estimated. Countries are grouped according to the regions described by *The World Factbook* (CIA 2021).

Source(s):
National Center for Science and Engineering Statistics, estimates as of December 2021. Based on data from Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (September 2021 edition), and United Nations Educational, Scientific and Cultural Organization, Institute for Statistics, Science Technology and Innovation data set (March 2021 release).

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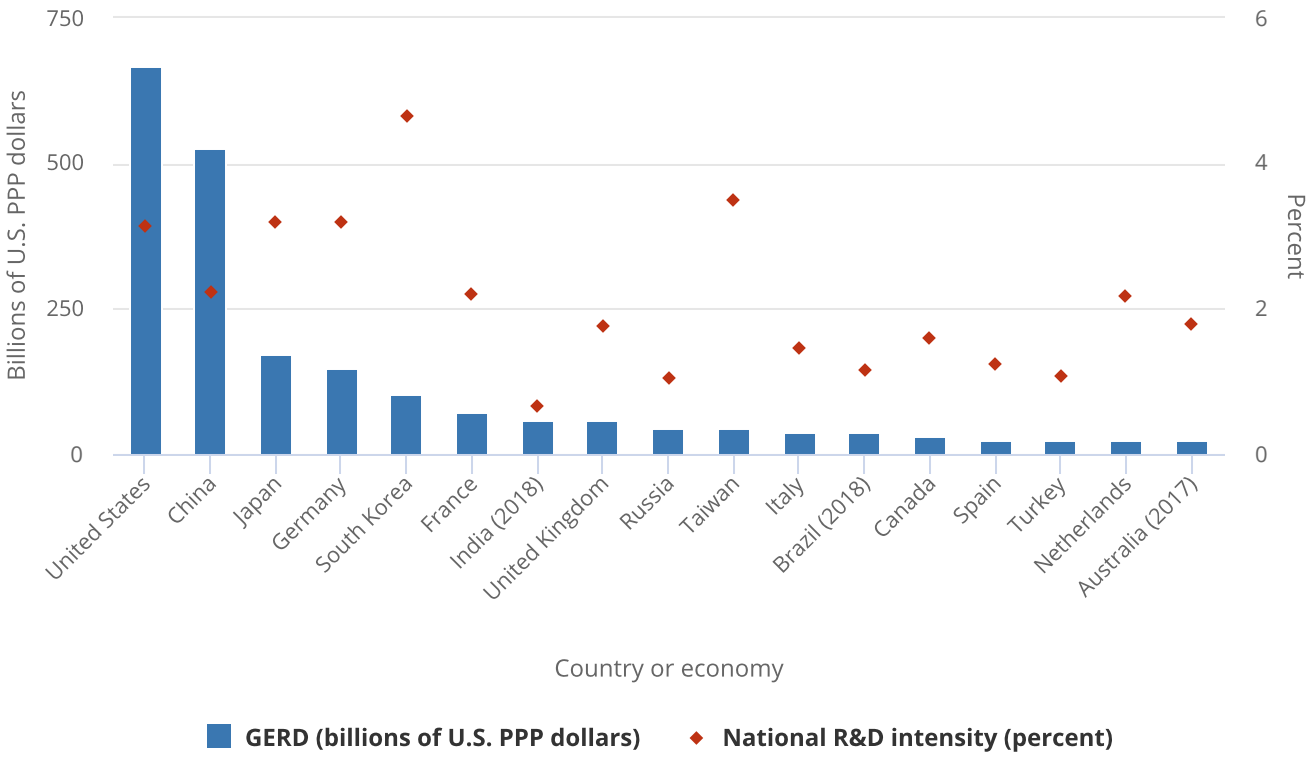
R&D performance is even more concentrated when comparing individual countries. The United States and China lead R&D performance globally, jointly accounting for half of global R&D (**Figure RD-6**). The United States performed $668.4 billion (28%) of global R&D in 2019.[15] China followed, with $525.7 billion (22%) of global R&D.

Figure RD-6

GERD and R&D intensity for world's top 17 R&D-performing countries and economies: 2019 or most recent data year



GERD = gross domestic expenditure on R&D; PPP = purchasing power parity.

Note(s):
Top 17 R&D-performing countries or economies (based on annual GERD). Data for most countries are from 2019; data for India, Brazil, and Australia are 1 year or 2 years earlier. National R&D intensity is the ratio of gross domestic expenditures on R&D to gross domestic product.

Source(s):
National Center for Science and Engineering Statistics, National Patterns of R&D Resources (2019–20 edition); Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (September 2021 edition); United Nations Educational, Scientific and Cultural Organization, Institute for Statistics, Science Technology and Innovation data set (March 2021 release).

Science and Engineering Indicators

The next tier of top R&D performers includes Japan (7% of global R&D), Germany (6%), and South Korea (4%), each with R&D expenditures above $100 billion. Together with the United States and China, these countries accounted for two-thirds of global R&D in 2019.

France, India, and the United Kingdom make up the third tier of top R&D performers, each with R&D expenditures above $50 billion, or around 2%–3% of the global R&D total. The fourth tier includes Russia, Taiwan, Italy, and Brazil, each with R&D expenditures from $36 billion to $45 billion, or 1.5%–2.0% of the global R&D total. Canada, Spain, Turkey, the Netherlands, and Australia follow, with R&D expenditures between $22 billion and $30 billion, or about 1% of the global R&D total each.

These top 17 R&D-performing countries collectively performed 87% of the global R&D in 2019 (**Figure RD-6**). Many other countries also perform R&D but do so at a comparatively much smaller scale (**Table RD-5**).

Table RD-5

International comparisons of gross domestic expenditures on R&D and R&D share of gross domestic product, by region, country, or economy: 2019 or most recent year

(Millions of U.S. PPP dollars and percent)

Region, country, or economy	GERD (PPP US$millions)	GERD-to-GDP ratio (percent)
North America		
United States (2019)[a]	668,351.2	3.13
Canada (2019)	30,312.7	1.59
Mexico (2019)	7,407.7	0.28
Central America and Caribbean		
Ecuador (2014)	827.1	0.44
Cuba (2011)	582.7	0.27
South America		
Brazil (2018)	36,315.5	1.16
Argentina (2019)	4,811.5	0.46
Colombia (2019)	2,514.2	0.32
Chile (2018)	1,623.4	0.35
Europe		
Germany (2019)	148,149.8	3.19
France (2019)	73,286.5	2.20
United Kingdom (2019)	56,935.7	1.76
Italy (2019)	39,279.4	1.47
Spain (2019)	24,874.2	1.25
Netherlands (2019)	22,609.4	2.18
Sweden (2019)	19,269.0	3.39
Belgium (2019)	19,938.2	3.17
Switzerland (2017)	18,565.6	3.18
Poland (2019)	17,164.1	1.32
Austria (2019)	16,297.4	3.13
Denmark (2019)	10,216.2	2.91
Czechia (2019)	8,911.2	1.94
Finland (2019)	7,956.4	2.79
Norway (2019)	7,869.4	2.15
Ireland (2019)	5,420.0	1.23
Portugal (2019)	5,303.8	1.40
Hungary (2019)	4,902.5	1.48
Greece (2019)	4,218.3	1.27
Romania (2019)	2,995.1	0.48
Ukraine (2018)	2,514.8	0.47
Slovenia (2019)	1,761.2	2.05
Slovakia (2019)	1,468.6	0.83
Bulgaria (2018)	1,199.8	0.76
Serbia (2018)	1,127.9	0.92
Belarus (2018)	1,108.1	0.60
Croatia (2018)	1,114.0	0.97
Lithuania (2018)	1,078.5	1.00
Luxembourg (2019)	849.5	1.13
Estonia (2019)	830.0	1.61
Iceland (2019)	503.7	2.33
Middle East		
Turkey (2019)	24,243.4	1.06
Israel (2019)	18,740.6	4.93
Saudi Arabia (2013)	13,696.0	0.82

Table RD-5

International comparisons of gross domestic expenditures on R&D and R&D share of gross domestic product, by region, country, or economy: 2019 or most recent year

(Millions of U.S. PPP dollars and percent)

Region, country, or economy	GERD (PPP US$millions)	GERD-to-GDP ratio (percent)
Iran (2017)	9,736.2	0.83
United Arab Emirates (2018)	8,439.6	1.28
Qatar (2018)	1,369.6	0.51
Africa		
Egypt (2018)	8,289.3	0.72
South Africa (2017)	6,025.6	0.83
Algeria (2017)	2,595.8	0.54
Morocco (2010)	1,485.1	0.71
Nigeria (2007)	829.5	0.13
Tunisia (2018)	766.2	0.60
Kenya (2010)	763.6	0.79
Ethiopia (2017)	590.2	0.27
Tanzania (2013)	531.7	0.51
Central Asia		
Russia (2019)	44,500.5	1.04
Kazakhstan (2018)	558.3	0.12
South Asia		
India (2018)	58,721.4	0.65
Pakistan (2017)	2,245.4	0.24
East and Southeast Asia		
China (2019)	525,693.4	2.23
Japan (2019)	173,267.1	3.20
South Korea (2019)	102,521.4	4.64
Taiwan (2019)	44,014.3	3.49
Thailand (2017)	12,078.4	1.00
Singapore (2018)	10,530.5	1.84
Malaysia (2018)	9,250.0	1.04
Indonesia (2018)	7,051.4	0.23
Vietnam (2017)	3,565.6	0.53
Philippines (2015)	1,150.9	0.16
Australia and Oceania		
Australia (2017)	22,376.2	1.79
New Zealand (2019)	3,159.4	1.41
Selected country groups		
European Union (2019)[b]	440,336.6	2.12
OECD (2019)	1,564,092.2	2.48
G20 countries (2019)	2,227,506.2	2.09

GDP = gross domestic product; GERD = gross domestic expenditure on R&D; G20 = Group of Twenty; OECD = Organisation for Economic Co-operation and Development; PPP = purchasing power parity.

[a] Data for U.S. GERD differ slightly from the U.S. total R&D data tabulated earlier in this report. For better consistency with international standards, U.S. GERD includes federal capital funding for federal intramural and nonprofit R&D, in addition to what is reported as U.S. total R&D.

[b] Data for the European Union (EU) include the 27 EU member countries.

Note(s):
Year of data is listed in parentheses. Foreign currencies are converted to dollars through PPPs. Countries in this table have an annual GERD of $500 million or more. Countries are grouped according to the regions described by *The World Factbook* (CIA 2021). Data for Israel are civilian R&D only. See sources below for GERD statistics on additional countries.

Source(s):
National Center for Science and Engineering Statistics, National Patterns of R&D Resources (2019–20 edition); Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (September 2021 edition); United Nations Educational, Scientific and Cultural Organization, Institute for Statistics, Science Technology and Innovation data set (March 2021 release).

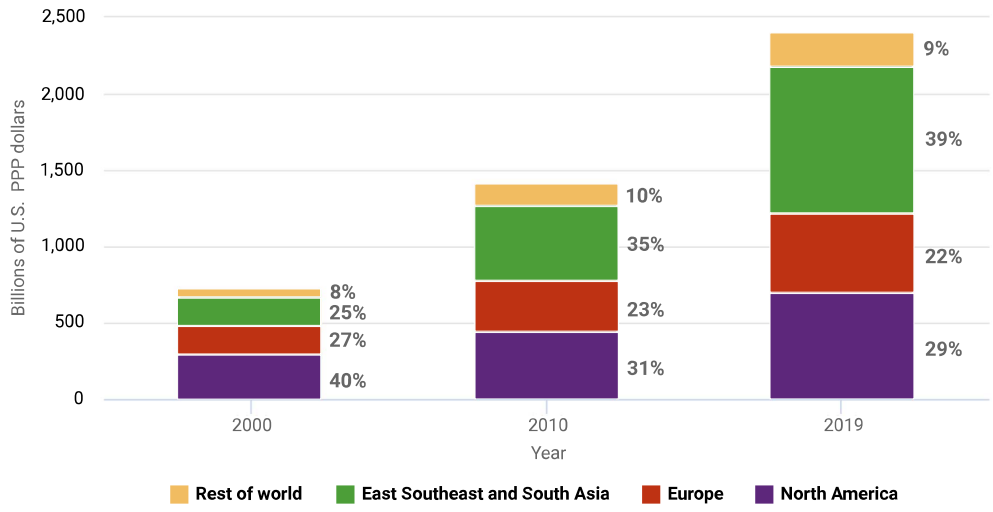
Science and Engineering Indicators

Trends in Total National R&D

Total global R&D expenditures continue to rise substantially as countries intensify their R&D efforts. Global R&D expenditures increased more than threefold from 2000 ($725.0 billion) to 2019 ($2.4 trillion) (**Figure RD-7**). The annual increase in global total R&D averaged 6.9% over the 2000–10 period and 6.2% for 2010–19.

Figure RD-7

Global R&D expenditures, by region: 2000, 2010, and 2019



PPP = purchasing power parity.

Note(s):
Foreign currencies are converted to dollars through PPPs. Some country data are estimated. Countries are grouped according to the regions described by *The World Factbook* (CIA 2021).

Source(s):
National Center for Science and Engineering Statistics, estimates as of December 2021. Based on data from Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (September 2021 edition), and United Nations Educational, Scientific and Cultural Organization, Institute for Statistics, Science Technology and Innovation data set (March 2021 release).

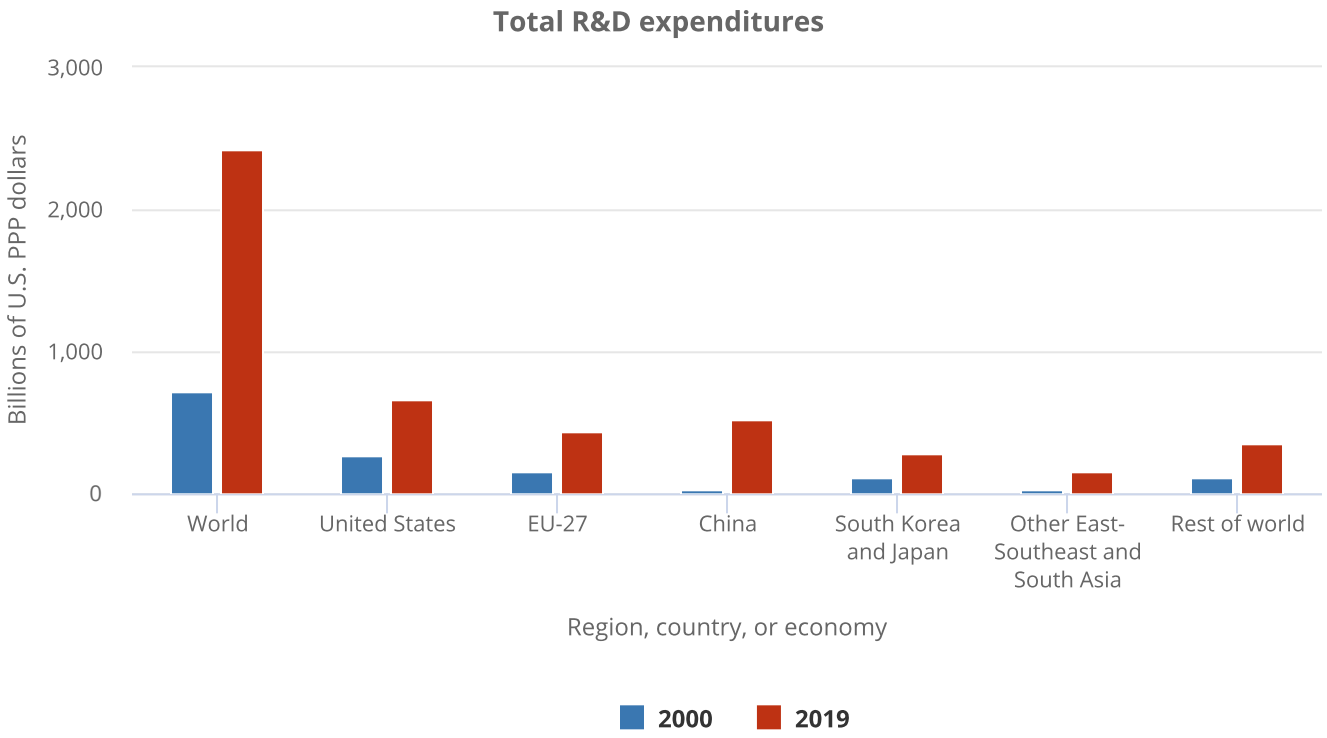
Science and Engineering Indicators

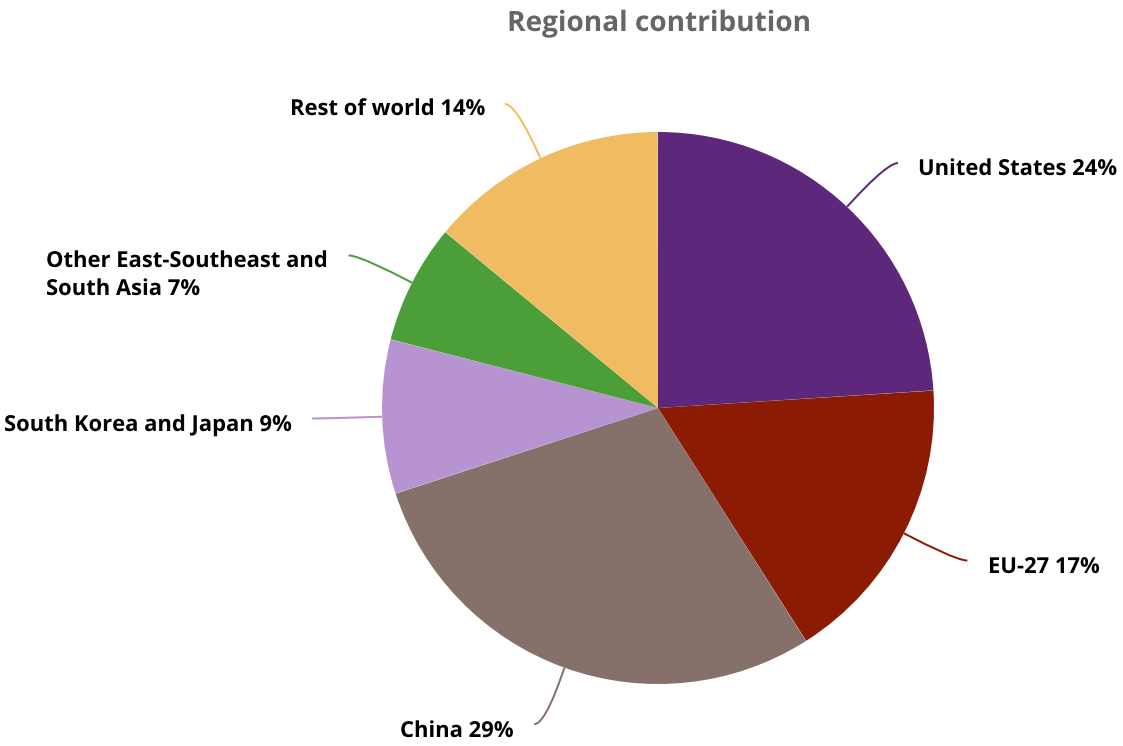
The global concentration of R&D performance continues to shift from North America and Europe to the East-Southeast and South Asia regions (**Figure RD-7**). R&D performed in North America accounted for 40% of the global total R&D in 2000 but only 29% in 2019. Europe accounted for 27% of global R&D in 2000 but declined to 22% in 2019. In contrast, the East-Southeast and South Asia regions accounted for 25% of the global total R&D in 2000, and their global share rose to 39% in 2019.

China accounted for 29% ($492.8 billion) of the global increase in R&D since 2000 (**Figure RD-8**). The United States accounted for 24% ($399.8 billion), and the EU-27 member countries accounted for 17% ($281.5 billion). The increases of several other major Asian R&D performers were also noticeable: South Korea and Japan jointly accounted for 9% of the increase ($158.3 billion).

Figure RD-8

Total R&D expenditures and contributions to the increase in worldwide R&D expenditures, by selected region, country, or economy: 2000 and 2019





EU = European Union; PPP = purchasing power parity.

Note(s):
Other East-Southeast and South Asia include Brunei, Cambodia, India, Indonesia, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, and Vietnam.

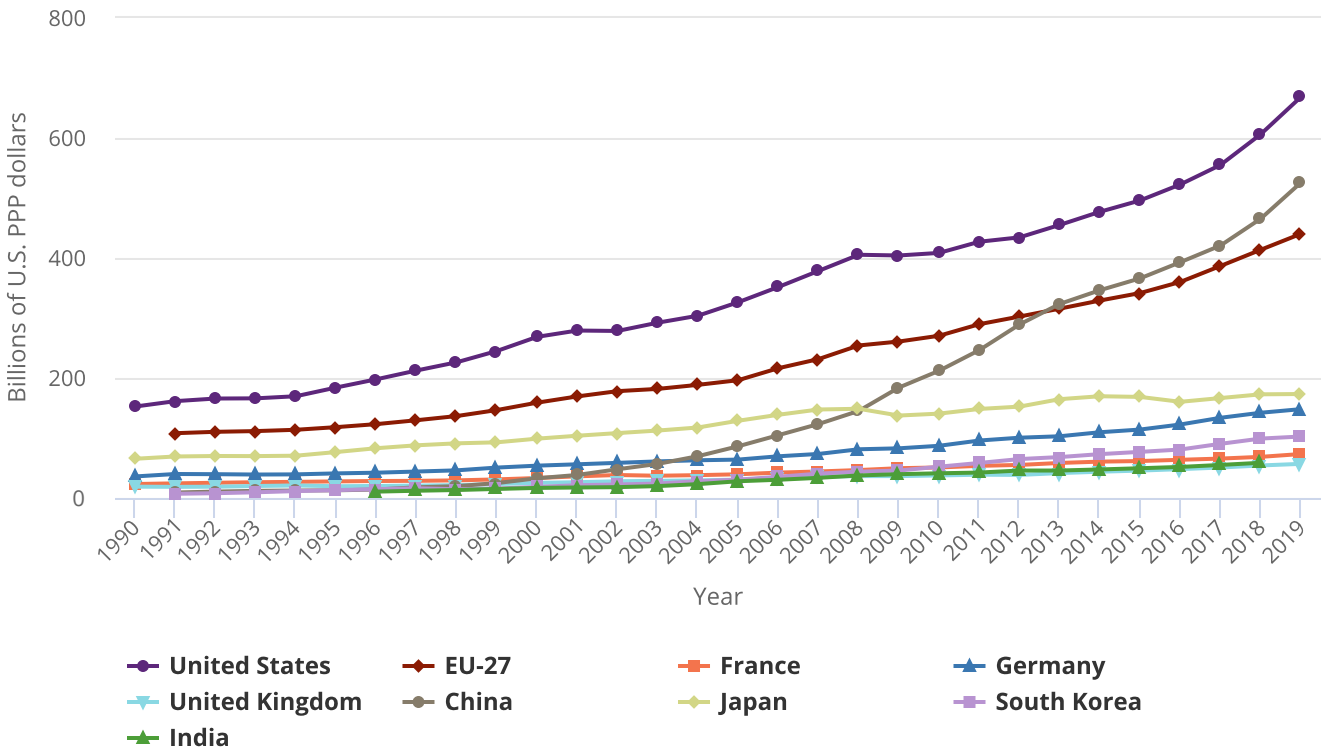
Source(s):
National Center for Science and Engineering Statistics, National Patterns of R&D Resources (2019–20 edition); Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (September 2021 edition); United Nations Educational, Scientific and Cultural Organization, Institute for Statistics, Science Technology and Innovation data set (March 2021 release).

Science and Engineering Indicators

The United States remains the leader among the world's R&D-performing nations; its rate of increase in R&D expenditures has averaged 4.3% over the 2000–10 period and 5.6% in 2010–19 (**Figure RD-9**; **Table RD-6**; Table SRD-1). R&D expenditures in China continue to increase at the world's fastest pace. The rate of China's increase in R&D performance has been remarkably high for many years, although it has slowed down in the last decade, averaging 10.6% annually over the 2010–19 period compared to 20.5% over the 2000–10 period.

Figure RD-9

Gross domestic expenditures on R&D, by selected region, country, or economy: 1990–2019



EU = European Union; PPP = purchasing power parity.

Note(s):
Data are for the top eight R&D-performing countries and the EU. Data are not available for all countries for all years. Data for U.S. gross domestic expenditure on R&D (GERD) differ slightly from the U.S. total R&D data tabulated earlier in this report. For better consistency with international standards, U.S. GERD includes federal capital funding for federal intramural and nonprofit R&D in addition to what is reported as U.S. total R&D. Data for Japan from 1996 onward may not be consistent with earlier data because of changes in methodology. Data for the EU include the 27 EU member countries. See also Table SRD-1.

Source(s):
National Center for Science and Engineering Statistics, National Patterns of R&D Resources (2019–20 edition); Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (September 2021 edition); United Nations Educational, Scientific and Cultural Organization, Institute for Statistics, Science Technology and Innovation data set (March 2021 release).

Science and Engineering Indicators

Table RD-6

Comparative growth rates for gross domestic expenditures on R&D and gross domestic product, top R&D-performing countries: 2000–10 and 2010–19

(Billions of U.S. PPP dollars and percent)

Country	Current measures		Longer-term growth rates			
	GERD (PPP US$billions)	GERD/ GDP (%)	GERD		GDP	
			2000–10	2010–19	2000–10	2010–19
United States (2019)[a]	668.4	3.13	4.3	5.6	3.9	4.1
China (2019)	525.7	2.23	20.5	10.6	12.9	7.4
Japan (2019)	173.3	3.20	3.6	2.4	2.7	2.0
Germany (2019)	148.1	3.19	4.9	6.1	3.6	4.3

Table RD-6

Comparative growth rates for gross domestic expenditures on R&D and gross domestic product, top R&D-performing countries: 2000–10 and 2010–19

(Billions of U.S. PPP dollars and percent)

Country	Current measures		Longer-term growth rates			
	GERD (PPP US$billions)	GERD/ GDP (%)	GERD		GDP	
			2000–10	2010–19	2000–10	2010–19
South Korea (2019)	102.5	4.64	10.9	7.8	6.1	3.8
France (2019)	73.3	2.20	4.3	4.1	3.9	4.0
India (2018)[b]	58.7	0.65	9.4	4.4	9.0	7.0
United Kingdom (2019)	56.9	1.76	4.1	4.7	3.9	3.9

GDP = gross domestic product; GERD = gross domestic expenditure on R&D; PPP = purchasing power parity.

[a] Data for U.S. GERD differ slightly from the U.S. total R&D data tabulated earlier in this report. For better consistency with international standards, U.S. GERD includes federal capital funding for federal intramural and nonprofit R&D in addition to what is reported as U.S. total R&D.

[b] Most recent data for India are 2018. The listed growth rates for India for both GERD and GDP are 2010–18.

Note(s):
Table shows the top eight R&D-performing countries in 2019. The growth rates are calculated as compound average annual rates. Year of data is listed in parentheses. By way of comparison, the National Center for Science and Engineering Statistics estimates that the average annual pace of growth of the global total of R&D was 6.9% for 2000–10 and 6.2% for 2010–19.

Source(s):
National Center for Science and Engineering Statistics, National Patterns of R&D Resources (2019–20 edition); Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (September 2021 edition); United Nations Educational, Scientific and Cultural Organization, Institute for Statistics, Science Technology and Innovation data set (March 2021 release).

Science and Engineering Indicators

The latest data show a more pronounced gap in R&D expenditures between the United States and China than previously measured. *Indicators 2020* reported China's R&D expenditures for 2017 at $496.0 billion, or 90% of the U.S. level of $549.0 billion (NSB ***Indicators 2020***: **Figure 4-7**). In comparison, current data place China's level of annual total R&D expenditures in 2017 at $420.8 billion, or 76% of the U.S. level of $555.1 billion. This reset in China's R&D expenditure levels stems entirely from the conversion of China's R&D data to U.S. PPP dollars following the latest release of PPP data by the International Comparison Program (ICP) at the World Bank.[16] This release included benchmark PPP data for the new reference year 2017, revised PPP data for reference year 2011, and annual PPPs for non-benchmark years (2012–16).[17] According to OECD (2020), the revised PPPs for China imply a higher cost of performing R&D because China's relative price of investment had been previously underestimated. In addition to the reset in China's R&D expenditure levels, the U.S. R&D expenditure total for 2017 was also revised upward by several billions of dollars as a result of a number of revisions. Even so, China continues to move closer to the United States (**Figure RD-9**). China's total R&D expenditures in 2019 were 79% of the U.S. level.

Among other top R&D-performing Asian countries, the rise in R&D expenditures in South Korea has also been quite high, averaging 10.9% annually over 2000–10 and 7.8% for 2010–19 (**Figure RD-9**; **Table RD-6**; Table SRD-1). India's increase in R&D expenditures averaged 9.4% annually over 2000–10 and 4.4% for 2010–19. Japan's corresponding increases of R&D have been considerably slower, at 3.6% and 2.4%, respectively.

Total R&D expenditures by the EU-27 nations have been increasing at an annual average rate of about 5.5% over both 2000–10 and 2010–19, with Germany at 4.9% and 6.1% and France at 4.3% and 4.1%, respectively (Table SRD-1). Over the same periods, the R&D expenditures in the United Kingdom have been increasing at 4.1% and 4.7%, respectively.

Patterns and Trends in National R&D Intensity

Country Patterns in National R&D Intensity, 2019

Despite ranking at the top of the R&D-performing countries by total R&D expenditures, the United States ranked ninth in national R&D intensity (the GERD-to-GDP ratio) among the economies tracked by OECD and UNESCO data (**Table RD-5**). The United States is one of ten countries overall and one of five top R&D-performing countries with R&D intensities above 3.0% (**Figure RD-6**; **Table RD-5**). Other top R&D-performing countries with R&D intensities above 3.0% are Japan (3.20%), Germany (3.19%), and South Korea (4.64%).

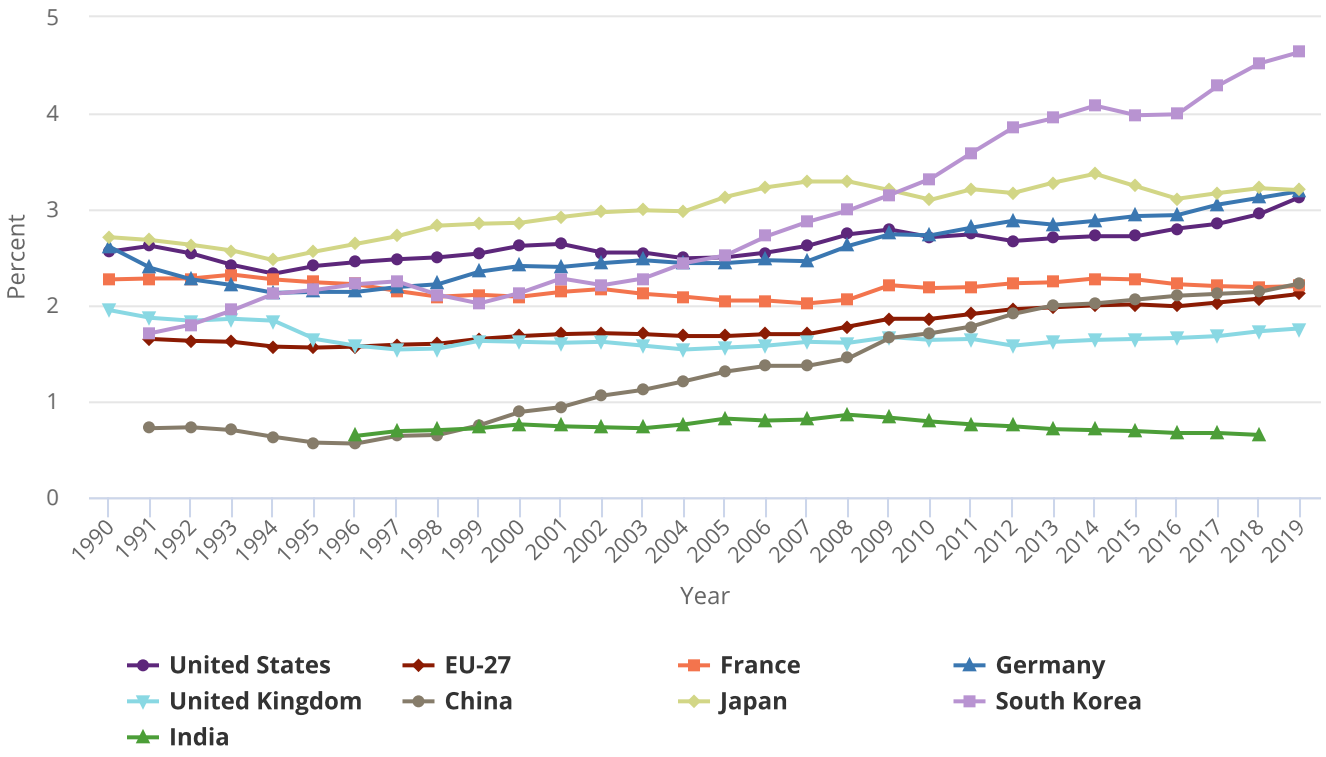
Israel and South Korea have the highest R&D intensities across all countries. Israel continues to hold the top spot, with an R&D intensity of 4.93% (**Table RD-5**). Israel, however, ranks 19th by total R&D expenditures. South Korea (4.64%) is second and the only country among the largest R&D-performing countries with an R&D intensity above 4.50%. Taiwan comes in third (3.49%), followed by Sweden (3.39%). Other countries with comparatively high R&D intensity ratios are Austria (3.13%) and Switzerland (3.18%). The R&D intensities of the remaining top R&D performers are as follows: China at 2.23%, France at 2.20%, the United Kingdom at 1.76%, and India at 0.65%.

Trends in National R&D Intensity

R&D intensity increased across several of the top R&D-performing countries in 2019 (**Figure RD-10**). U.S. R&D intensity has ranged from 2.5% to under 3.0% since 2000 and, for the first time, reached 3.13% in 2019 (**Figure RD-10**; Table SRD-1). The U.S. rank in this indicator has changed over time, fluctuating between 8th and 11th (NSB ***Indicators 2012***, ***Indicators 2014***, ***Indicators 2016***, ***Indicators 2018***, ***Indicators 2020***). Despite historically high U.S. R&D intensity levels, these rank changes are not surprising as other countries have been expanding their R&D efforts.

Figure RD-10

Gross domestic expenditures on R&D as a share of gross domestic product, by selected region, country, or economy: 1990–2019



EU = European Union.

Note(s):
Data are for the top eight R&D-performing countries and the EU. Data are not available for all countries for all years. Data for U.S. gross domestic expenditure on R&D (GERD) differ slightly from the U.S. total R&D data tabulated earlier in this report. For better consistency with international standards, U.S. GERD includes federal capital funding for federal intramural and nonprofit R&D in addition to what is reported as U.S. total R&D. Data for Japan in 1996 onward may not be consistent with earlier data because of changes in methodology. Data for the EU include the 27 EU member countries. See also Table SRD-1.

Source(s):
National Center for Science and Engineering Statistics, National Patterns of R&D Resources (2019–20 edition); Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (September 2021 edition); United Nations Educational, Scientific and Cultural Organization, Institute for Statistics, Science Technology and Innovation data set (March 2021 release).

Science and Engineering Indicators

R&D intensity has been rising gradually for European countries. For EU-27 member countries, R&D intensity has increased from about 1.68% in 2000 to 2.12% in 2019 (**Figure RD-10**; Table SRD-1). For the largest R&D performers among the EU-27 countries, Germany's ratio has risen the most over this period, from 2.41% to 3.19%, while France's ratio has had modest increases, from 2.09% to 2.20%. The R&D intensity for the United Kingdom has also increased modestly from 1.62% to 1.76%.

Among top R&D-performing Asian countries, China and South Korea have had the largest increases in R&D intensity in the last two decades (**Figure RD-10**; Table SRD-1). China's ratio more than doubled, from 0.89% in 2000 to 2.23% in 2019. South Korea's ratio has also more than doubled from 2.13% in 2000 to 4.64% in 2019; its growth in R&D intensity has been particularly rapid since the late 1990s (**Figure RD-10**). Japan's R&D intensity has fluctuated around 3.10%–3.30% for most of the last decade, having increased from 2.86% in 2000.

Comparisons of the Composition of Country R&D Performance and Funding

Trends in Composition, by Sector

The business sector dominates R&D performance in seven of the eight top R&D-performing nations (**Table RD-7**). This sector accounted for three-fourths of R&D performance in the United States (75%) in 2019. Business shares were even larger among the leading Asian R&D performers: China (76%), Japan (79%), and South Korea (80%). The European countries had comparatively lower shares, with Germany at 69%, France at 66%, and the United Kingdom at 67%. India's business share was the lowest at 37%.

Table RD-7

Gross expenditures on R&D for selected countries, by performing sector and source of funds: 2019 or most recent year

(Billions of U.S. PPP dollars and percent share)

Country	GERD (PPP US$billions)	R&D performance: Share of total (percent)				R&D source of funds: Share of total (percent)			
		Business	Government	Higher education	Private nonprofit[a]	Business	Government	Other domestic	Rest of the world
United States (2019)[b]	668.4	74.5	9.7	11.7	4.1	65.0	21.0	6.8	7.2
China (2019)	525.7	76.4	15.5	8.1	na	76.3	20.5	NA	0.1
Japan (2019)	173.3	79.2	7.8	11.7	1.3	78.9	14.7	5.8	0.6
Germany (2019)	148.1	68.9	13.7	17.4	na	64.5	27.8	0.4	7.4
South Korea (2019)	102.5	80.3	10.0	8.3	1.4	76.9	20.7	0.8	1.6
France (2019)	73.3	65.8	12.4	20.1	1.8	56.7	32.5	2.8	8.0
India (2018)[c]	58.7	36.8	56.1	7.1	0.0	36.8	63.2	0.0	0.0
United Kingdom (2019)[d]	56.9	66.6	6.6	23.1	2.3	54.8	25.9	5.6	13.7

na = not applicable; country does not recognize the category or does not report the data item. NA = not available.

GERD = gross domestic expenditure on R&D; PPP = purchasing power parity.

[a] The private nonprofit sector comprises all nonprofit institutions serving households except those classified as part of the higher education sector.

[b] Data for U.S. GERD differ slightly from the U.S. total R&D data tabulated earlier in this report. For better consistency with international standards, U.S. GERD includes federal capital funding for federal intramural and nonprofit R&D in addition to what is reported as U.S. total R&D. The data for U.S. funding from the rest of the world include funding for business R&D and academic R&D.

[c] For India, the most recent year of available data on GERD and the distribution of R&D performance is 2018, whereas the most recent year available for data on distribution of R&D expenditures by source of funds is 2017.

[d] For the United Kingdom, the most recent year available for data on distribution of R&D expenditures by source of funds is 2018.

Note(s):
Table shows the top eight R&D-performing countries in 2019. Year of data is listed in parentheses. Percentages may not add to 100% because of rounding. Germany's expenditures of the nonprofit sector are included in data for other performing sectors. Classification of sectors follows Organisation for Economic Co-operation and Development surveys.

Source(s):
National Center for Science and Engineering Statistics, National Patterns of R&D Resources (2019–20 edition); Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (September 2021 edition); United Nations Educational, Scientific and Cultural Organization, Institute for Statistics, Science Technology and Innovation data set (March 2021 release).

Science and Engineering Indicators

The government sector performed more than half of India's R&D (56%) (**Table RD-7**). Government-performed R&D ranged from about 7% to 15% for the remaining top eight R&D-performing countries, with China (15%) and Germany (14%) on the higher end and the United Kingdom (7%) and Japan (8%) on the lower end. The higher education sector accounted for 20% or more of R&D performance in France (20%) and the United Kingdom (23%) and for 7%–17% of R&D performance in the remaining top eight countries. India (7%), China (8%), and South Korea (8%) had the lowest shares of R&D performance by this sector.

The business sector is also the predominant source of R&D funding for most top R&D-performing countries; government is the second-largest source (**Table RD-7**). The business sector accounted for 55%–79% of R&D funding, while the government sector accounted for 15%–33% among the top eight countries, except for India. The government sector is the largest source of R&D funding in India (63%), with the rest (37%) funded by the business sector.

Funding from *rest of world* refers to funding from businesses, universities, governments, nonprofits, and other organizations located outside of the country. The United Kingdom is the most notable in this category, with about 14% of R&D funding in 2018 coming from foreign sources. Foreign funding was also sizable in France, Germany, and the United States (around 7%–8%), while the rest of the top R&D-performing countries had much lower shares for this funding source.

The distributions of R&D performance and funding have been relatively stable for these countries since 2011 (NSB ***Indicators 2012***, ***Indicators 2014***, ***Indicators 2016***, ***Indicators 2018***, ***Indicators 2020***).

Trends in Composition, by Type of R&D

Cross-national comparisons of R&D levels and shares of national R&D performance devoted to basic research, applied research, and experimental development provide useful insights into how countries prioritize their allocation of resources for R&D.

France leads the top eight R&D-performing countries in the share of basic research (23%), although France's R&D expenditures spent on basic research ($15.6 billion) are relatively low compared to other top R&D-performing countries (**Table RD-8**). In contrast, China's basic research share is the lowest among the top R&D-performing countries (6%), but the R&D expenditures for basic research in China ($31.7 billion) are higher than in France. By volume of spending, the United States leads performance of global basic research with $102.9 billion in R&D expenditures in 2019, which accounts for 15% of its total R&D expenditures.

Table RD-8

Gross expenditures on R&D for selected countries, by type of R&D: 2019 or most recent year

(Billions of U.S. PPP dollars and percent share)

Country	GERD (PPP US$billions)	Basic[a]	Applied	Experimental development	Capital expenditures nec[b]
Billions of U.S. PPP dollars					
United States (2019)[c]	668.4	102.9	132.0	432.0	1.5
China (2019)	525.7	31.7	59.3	434.7	0.0
Japan (2019)	173.3	21.7	32.2	112.3	7.2
Germany (2019)	148.1	NA	NA	NA	NA
South Korea (2019)	102.5	15.0	23.1	64.4	0.0
France (2018)	68.6	15.6	28.3	24.7	0.0
India (2017)	55.1	7.9	12.2	10.8	24.2
United Kingdom (2018)	54.2	9.9	22.8	21.5	0.0
Percent share of total					
United States (2019)	100.0	15.4	19.8	64.6	0.2
China (2019)	100.0	6.0	11.3	82.7	0.0
Japan (2019)	100.0	12.5	18.6	64.8	4.1
Germany (2019)	NA	NA	NA	NA	NA
South Korea (2019)	100.0	14.7	22.5	62.8	0.0
France (2018)	100.0	22.7	41.3	36.1	0.0
India (2017)	100.0	14.4	22.2	19.5	43.8
United Kingdom (2018)	100.0	18.3	42.1	39.7	0.0

NA = not available.

GERD = gross domestic expenditure on R&D; nec = not elsewhere classified; PPP = purchasing power parity.

[a] Expressed as a share of GDP, the country expenditures for basic research are United States (0.49%), China (0.12%), Japan (0.41%), Germany (NA), South Korea (0.64%), France (0.50%), India (0.09%), and United Kingdom (0.32%).

[b] This category includes capital expenditures nec. Capital expenditures are the annual gross amount paid for the acquisition of fixed assets such as R&D plant and equipment.

[c] Data for U.S. GERD differ slightly from the U.S. total R&D data tabulated earlier in this report. For better consistency with international standards, U.S. GERD includes federal capital funding for federal intramural and nonprofit R&D in addition to what is reported as U.S. total R&D.

Note(s):
Table shows the top eight R&D-performing countries in 2019. Year of data is listed in parentheses. Detail may not add to total because of rounding. Data are not presently available for Germany.

Source(s):
National Center for Science and Engineering Statistics, National Patterns of R&D Resources (2019–20 edition); Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (September 2021 edition); United Nations Educational, Scientific and Cultural Organization, Institute for Statistics, Science Technology and Innovation data set (March 2021 release).

Science and Engineering Indicators

The United Kingdom and France have the largest shares of R&D expenditures devoted to applied research among these countries (each above 40%). Shares for the remaining countries range from 11% (China) to 22%–23% (India and South Korea). By volume of spending, the United States also dominates this category with $132.0 billion of applied research spending in 2019, which accounts for 20% of its total R&D expenditures. The overall volume of spending by the second- and third-ranked countries in this category are comparatively far behind: China, at $59.3 billion, and Japan, at $32.2 billion.

China has the highest share of experimental development by far—83% of its R&D total in 2019, or $434.7 billion of spending in this category. For the United States, the experimental development share was 65%, although the amount of spending was virtually identical to China ($432.0 billion). Other countries with comparatively high shares for experimental development are Japan (65%) and South Korea (63%); the dollar amounts of these countries' performances, however, were well below the levels for China and the United States.

The R&D expenditure shares by type of R&D reported by the countries have been largely stable over the past several years (NSB ***Indicators 2012***, ***Indicators 2014***, ***Indicators 2016***, ***Indicators 2018***, ***Indicators 2020***).

U.S. Business R&D

The business sector plays an integral role in the U.S. R&D system. It is diverse in its industrial composition, products, production processes, and input requirements, including requirements for R&D. It drives many of the nation's R&D activities as the largest performer and funder of U.S. R&D. Importantly, the business sector is also a major contributor to U.S. basic research.

This section provides a more detailed account of the R&D performance and funding roles of the business sector, and it is organized in two parts. It first discusses key characteristics of U.S. business R&D, including R&D performance and R&D intensity by top R&D-performing industries, sources of funding, and a breakdown of R&D performance by company size and by type of R&D. It then contrasts the U.S. business R&D data with broadly comparable data for the largest R&D-performing countries.

Key Characteristics of Domestic Business R&D Performance

U.S. business R&D is the R&D performed by companies that are resident in the United States. It includes the R&D performed by the company and paid for by the company itself (from company-owned, U.S.-located units or from subsidiaries overseas). It also includes the R&D performed by the company and paid for by others, such as other companies (domestic or foreign, including parent companies of foreign-owned subsidiaries located in the United States), the U.S. federal government, nonfederal governments (state and local or foreign), and nonprofit or other organizations (domestic or foreign).

The primary source for U.S. business R&D data is NCSES's Business Enterprise Research and Development Survey (BERD) and its predecessors, the Business Research and Development Survey (BRDS) and the Business R&D and Innovation Survey (BRDIS)[18]. The BERD sample represents all for-profit, nonfarm companies with 10 or more domestic employees, publicly or privately held in the United States that perform or fund R&D domestically or abroad. Data on R&D activities of microbusinesses—businesses with less than 10 employees—are collected by NCSES's Annual Business Survey (ABS). The ABS was recently established to collect annual data on microbusiness R&D as well as data on innovation, intellectual property, technology, business owners, and business structure for all businesses located in the United States.

The data presented in this section classify a company's total R&D into a single industry according to the dominant business activity for domestic R&D performance. For a company with R&D expenses in multiple lines of business, all R&D expenses are assigned to the industry with the largest R&D expenditures. Most companies, however, perform R&D in one line of business (Shackelford 2012; Jankowski and Shackelford 2019).[19]

Analyses of U.S. business R&D performance in the last edition (NSB ***Indicators 2020***) of this report focused solely on R&D performed by businesses with 10 or more employees. These businesses perform nearly 99% of U.S. business R&D, and their R&D performance data are comparable with the international business statistics discussed later in the section. Furthermore, until recently, there were no data consistently collected on microbusiness R&D.

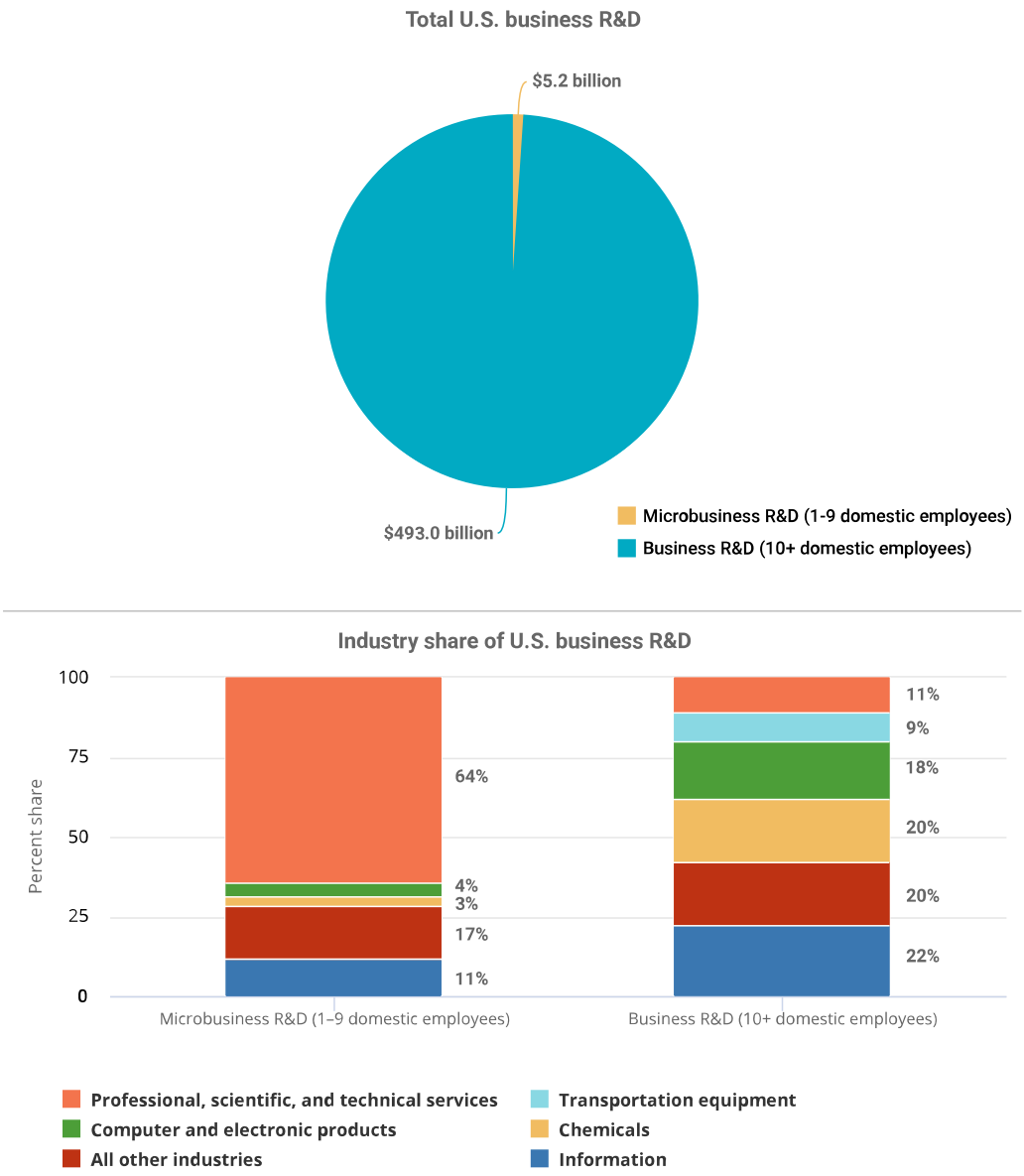
Microbusinesses are a small but important segment of the business sector due to their contribution to economic growth and innovation.[20] While the focus of the analysis remains on the R&D performance by larger businesses, this report provides new analysis on microbusiness R&D for a more comprehensive account of the R&D activities of the business sector.

Industries That Perform the Most U.S. Business R&D

Overall, the U.S. business sector performed $498.2 billion of R&D in 2019. The total U.S. business R&D performance consisted of $493.0 billion of R&D performed by businesses with 10 or more employees and $5.2 billion of R&D performed by microbusinesses (**Figure RD-11**). In the next several paragraphs, the analysis focuses on industry composition and trends of R&D performed by businesses with 10 or more employees, followed by a discussion of the industry composition of microbusiness R&D.

Figure RD-11

Top R&D-performing industries: 2019



Note(s):
All other industries include machinery; electrical equipment, appliance, and components; manufacturing not elsewhere classified; finance and insurance; and nonmanufacturing not elsewhere classified. See Table SRD-2 for a full list of industries.

Source(s):
National Center for Science and Engineering Statistics and U.S. Census Bureau, Business Enterprise Research and Development Survey (BERD), 2019, and special tabulations (2022) of the Annual Business Survey (ABS), data year 2019.

Science and Engineering Indicators

Almost 60% of the R&D performed by businesses with 10 or more employees was in the manufacturing sector, with the remaining 40% in the nonmanufacturing sector, which includes services (**Table RD-9**). Within these sectors, business R&D is concentrated in a few industries. Five industries accounted for 80% of the R&D performance by these businesses in 2019 (**Figure RD-11**; **Table RD-9**).

Table RD-9

Funds spent for business R&D performed in the United States, by source of funds and selected industry: 2019

(Millions of dollars and percent share)

Industry and NAICS code	All R&D[a]	Paid for by the company[b]	Paid for by others				
			Total	Federal	Companies		All other organizations[d]
					Domestic	Foreign[c]	
Millions of dollars							
All industries, 21–33, 42–81	492,956	428,968	63,989	21,941	21,461	19,554	1,033
Manufacturing industries, 31–33	285,674	248,109	37,564	16,023 i	5,470	15,749	322
Chemicals, 325	97,063	87,288	9,775	289	1,967	7,459	60
Pharmaceuticals and medicines, 3254	87,619	78,652	8,966	269	1,938	6,707	52
Other 325	9,444	8,636	809	20	29	752	8
Machinery, 333	15,184	13,930	1,254	193	371	689	1
Computer and electronic products, 334	86,729	75,570	11,159	5,802	1,679	3,604	74
Electrical equipment, appliances, and components, 335	5,263	4,886	377	27	30 i	317	3
Transportation equipment, 336	45,375	31,505	13,870 i	9,652 i	1,031	3,020	167
Motor vehicles, trailers, and parts, 3361–63	24,117	20,883	3,233 i	38 - 481	0 - 374	2,754	D
Aerospace products and parts, 3364	18,358 i	8,900	9,458 i	8,454 i	658	176 - 257	D
Other 336	2,900	1,722	1,179	D	D	D	D
Manufacturing nec, other 31–33	36,060	34,930	1,129	60 i	392	660	17
Nonmanufacturing industries, 21–23, 42–81	207,283	180,858	26,425	5,918	15,991 i	3,805	711
Information, 51	110,227	109,062	1,165	185	81	860	39
Software publishers, 5112	32,958	32,386	572	57	4	476	35
Other 51	77,269	76,676	593	128	77	384	4
Finance and insurance, 52	8,917	8,890	28	0	28	0	0
Professional, scientific, and technical services, 54	53,233	29,131	24,103	5,685	15,076 i	2,674	668
Computer systems design and related services, 5415	21,046	18,395	2,651	454	489	1,503	205
Scientific R&D services, 5417	21,669	3,265	18,403	3,343	13,741 i	1,002	317
Other 54	10,518	7,471	3,049	1,888	846	169	146
Nonmanufacturing nec, other 21–23, 42–81	34,906	33,775	1,129	48	806	271	4
Percent							
All industries, 21–33, 42–81	100.0	87.0	13.0	4.5	4.4	4.0	0.2
Manufacturing industries, 31–33	100.0	86.9	13.1	5.6	1.9	5.5	0.1
Chemicals, 325	100.0	89.9	10.1	0.3	2.0	7.7	0.1
Pharmaceuticals and medicines, 3254	100.0	89.8	10.2	0.3	2.2	7.7	0.1
Other 325	100.0	91.4	8.6	0.2	0.3	8.0	0.1
Machinery, 333	100.0	91.7	8.3	1.3	2.4	4.5	0.0
Computer and electronic products, 334	100.0	87.1	12.9	6.7	1.9	4.2	0.1
Electrical equipment, appliances, and components, 335	100.0	92.8	7.2	0.5	0.6	6.0	0.1
Transportation equipment, 336	100.0	69.4	30.6	21.3	2.3	6.7	0.4
Motor vehicles, trailers, and parts, 3361–63	100.0	86.6	13.4	0.2 - 2.0	0.0 - 1.6	11.4	D
Aerospace products and parts, 3364	100.0	48.5	51.5	46.1	3.6	1.0 - 1.4	D
Other 336	100.0	59.4	40.7	D	D	D	D
Manufacturing nec, other 31–33	100.0	96.9	3.1	0.2	1.1	1.8	0.0
Nonmanufacturing industries, 21–23, 42–81	100.0	87.3	12.7	2.9	7.7	1.8	0.3
Information, 51	100.0	98.9	1.1	0.2	0.1	0.8	0.0
Software publishers, 5112	100.0	98.3	1.7	0.2	0.0	1.4	0.1
Other 51	100.0	99.2	0.8	0.2	0.1	0.5	0.0

Table RD-9

Funds spent for business R&D performed in the United States, by source of funds and selected industry: 2019

(Millions of dollars and percent share)

Industry and NAICS code	All R&D[a]	Paid for by the company[b]	Paid for by others				
			Total	Federal	Companies		All other organizations[d]
					Domestic	Foreign[c]	
Finance and insurance, 52	100.0	99.7	0.3	0.0	0.3	0.0	0.0
Professional, scientific, and technical services, 54	100.0	54.7	45.3	10.7	28.3	5.0	1.3
Computer systems design and related services, 5415	100.0	87.4	12.6	2.2	2.3	7.1	1.0
Scientific R&D services, 5417	100.0	15.1	84.9	15.4	63.4	4.6	1.5
Other 54	100.0	71.0	29.0	18.0	8.0	1.6	1.4
Nonmanufacturing nec, other 21–23, 42–81	100.0	96.8	3.2	0.1	2.3	0.8	0.0

D = suppressed to avoid disclosure of confidential information; i = more than 50% of the estimate is a combination of imputation and reweighting to account for nonresponse.

NAICS = North American Industry Classification System; nec = not elsewhere classified.

[a] All R&D is the cost of R&D paid for and performed by the respondent company and paid for by others outside of the company and performed by the respondent company.

[b] Includes foreign subsidiaries of U.S. companies ($27.1 billion).

[c] Includes foreign parent companies of U.S. subsidiaries ($17.6 billion) and unaffiliated companies ($2.0 billion). Excludes funds from foreign subsidiaries to U.S. companies paid for through intercompany transactions ($27.1 billion).

[d] Includes U.S. state government agencies and laboratories (< $0.2 billion); U.S. universities, colleges, and academic researchers ($0.05 billion); and all other organizations located inside (< $0.8 billion) and outside the United States (< $0.05 billion).

Note(s):
Detail may not add to total because of rounding. Beginning in survey year 2018, companies that performed or funded less than $50,000 of R&D were excluded from tabulation. These companies in aggregate represented a very small share of total R&D expenditures in prior years. Had the companies under this threshold been included in the 2018 estimates, they would have contributed approximately $90 million to overall R&D expenditures. Industry classification was based on the dominant business code for domestic R&D performance, where available. For companies that did not report business codes, the classification used for sampling was assigned. Excludes data for federally funded research and development centers. An estimate range may be displayed in place of a single estimate to avoid disclosing operations of individual companies. The Business Enterprise Research and Development Survey includes only companies with 10 or more domestic employees.

Source(s):
National Center for Science and Engineering Statistics and U.S. Census Bureau, Business Enterprise Research and Development Survey, 2019.

Science and Engineering Indicators

- Chemicals manufacturing (North American Industry Classification System [NAICS] 325) accounted for nearly 20% ($97.1 billion) of business R&D performance, most of which was in the pharmaceuticals and medicines industry ($87.6 billion).
- Computer and electronic products manufacturing (NAICS 334) accounted for 18% ($86.7 billion) of business R&D performance.
- Transportation equipment manufacturing (NAICS 336, which includes the automobiles and aerospace industries) accounted for 9% ($45.4 billion) of business R&D performance.
- Information (NAICS 51) accounted for over 22% ($110.2 billion) of business R&D performance, about a third of which was in software publishing ($33.0 billion).

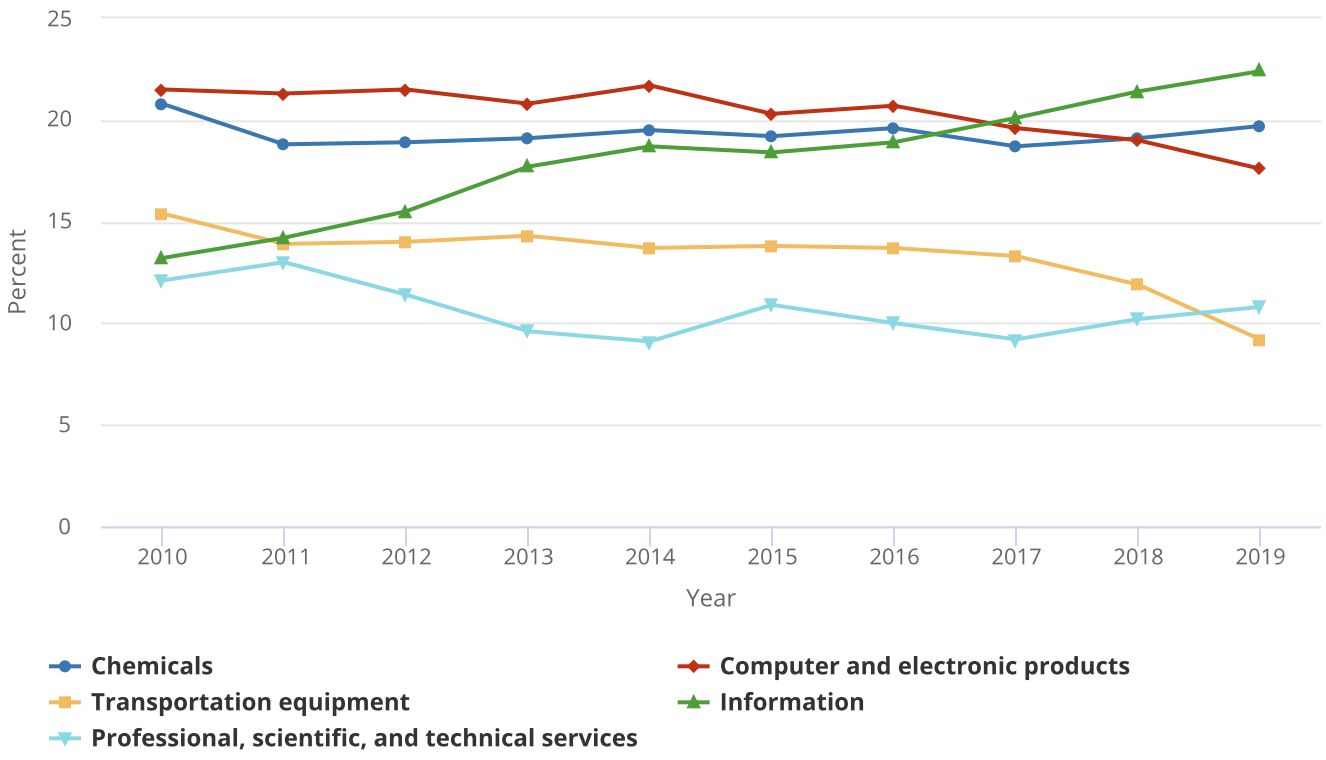
- Professional, scientific, and technical (PST) services (NAICS 54) accounted for 11% ($53.2 billion) of business R&D performance. Most of the R&D performed by the PST services industry was in scientific R&D services ($21.7 billion) and in computer systems design and related services ($21.0 billion).

Increases in R&D performed by businesses with 10 or more employees in recent years (2018 and 2019) have been large compared to earlier years (Table SRD-2). The $493.0 billion in R&D performance in 2019 represents a 12% increase (or $52 billion) over the 2018 level ($441.0 billion), and the latter is a 10% increase (or $41 billion) over the 2017 level ($400.1 billion). To put this into context, R&D performed by these businesses increased, on average, 5% annually from 2010 to 2017. Among the top R&D-performing industries, the largest increases in 2019 were in PST services, information, and chemicals manufacturing. R&D performance in the computer and electronic products and machinery manufacturing industries also increased. In contrast, R&D performance in the transportation equipment industry declined.

The distribution of R&D performed by businesses with 10 or more employees across industries has been stable for many industries since 2010 with a few notable exceptions (**Figure RD-12**; Table SRD-2). The industry share of total business R&D for the information industry increased by more than 9 percentage points during this period. In contrast, the share of the transportation equipment and computer and electronic products industries declined by 6 percentage points and 4 percentage points, respectively.

Figure RD-12

Industry share of total business R&D, by top R&D-performing industries: 2010–19



Note(s):
Industry classification is based on the dominant business code for domestic R&D performance, when available. For companies that did not report business codes, the classification used for sampling was assigned. Beginning in survey year 2018, statistics are representative of companies located in the United States that performed or funded $50,000 or more of R&D. The 2010–16 data come from the Business R&D and Innovation Survey and do not include companies with fewer than 5 domestic employees. Data for 2017–18 come from the Business Research and Development Survey, while data for 2019 come from the Business Enterprise Research and Development Survey; both surveys do not include companies with fewer than 10 domestic employees. Data for other industries are available in Table SRD-2.

Source(s):
National Center for Science and Engineering Statistics and U.S. Census Bureau, Business R&D and Innovation Survey (BRDIS), Business Research and Development Survey (BRDS), and Business Enterprise Research and Development Survey.

Science and Engineering Indicators

The top R&D-performing industries stand out not only by R&D performance levels but also by R&D intensities. Business R&D intensity—the share of a company's sales spent on R&D activities—is a key indicator of R&D investment and varies widely across industries. For the businesses with 10 or more employees, R&D intensity across all industries averaged 4.4% in 2019 (**Table RD-10**).

Table RD-10

Sales, R&D intensity, and employment for companies that performed or funded R&D, by selected industry: 2019

(Millions of dollars, percent, and thousands of domestic employees)

Industry and NAICS code	Domestic net sales (US$millions)[a]	R&D intensity (%)[b]	Domestic employment (thousands)[c]	
			Total	R&D[d]
All industries, 21–33, 42–81	11,180,864	4.4	21,213	1,832
Manufacturing industries, 31–33	5,675,165	5.0	10,100	962
Chemicals, 325	1,161,526	8.4	1,451	186
Pharmaceuticals and medicines, 3254	536,020	16.3	648	139
Other 325	625,506	1.5	803	47
Machinery, 333	363,337	4.2	869	95
Computer and electronic products, 334	678,010	12.8	1,167	264
Electrical equipment, appliances, and components, 335	142,538	3.7	319	25
Transportation equipment, 336	1,164,905	3.9	1,835	183
Motor vehicles, trailers, and parts, 3361–63	805,202	3.0	1,040	108
Aerospace products and parts, 3364	280,327	6.5	612	61
Other 336	79,376	3.6	183	14
Manufacturing nec, other 31–33	2,164,849	1.7	4,459	209
Nonmanufacturing industries, 21–23, 42–81	5,505,700	3.8	11,113	870
Information, 51	1,435,124	7.7	2,107	359
Software publishers, 5112	186,003	17.7	355	109
Other 51	1,249,121	6.2	1,752	250
Finance and insurance, 52	1,568,443	0.6	1,795	54
Professional, scientific, and technical services, 54	486,234	10.9	1,421	299
Computer systems design and related services, 5415	197,389	10.7	482	99
Scientific R&D services, 5417	81,094	26.7	300	98
Other 54	207,751	5.0	639	102
Nonmanufacturing nec, other 21–23, 42–81	2,015,899	1.7	5,790	158

NAICS = North American Industry Classification System; nec = not elsewhere classified.

[a] Dollar values are for goods sold or services rendered by R&D-performing or R&D-funding companies located in the United States to customers outside of the company, including the U.S. federal government, foreign customers, and the company's foreign subsidiaries. Included are revenues from a company's foreign operations and subsidiaries and from discontinued operations. If a respondent company is owned by a foreign parent company, sales to the parent company and to affiliates not owned by the respondent company are included. Excluded are intracompany transfers, returns, allowances, freight charges, and excise, sales, and other revenue-based taxes.

[b] R&D intensity is the cost of domestic R&D paid for by the respondent company and others outside of the company and performed by the company divided by domestic net sales of companies that performed or funded R&D.

[c] Data recorded on 12 March represent employment figures for the year.

[d] Includes researchers, R&D managers, technicians, clerical staff, and others assigned to R&D groups.

Note(s):
Detail may not add to total because of rounding. Beginning in survey year 2018, companies that performed or funded less than $50,000 of R&D were excluded from tabulation. These companies in aggregate represented a very small share of total R&D expenditures in prior years. Had the companies under this threshold been included in the 2018 estimates, they would have contributed approximately $90 million to overall R&D expenditures. Estimates of aggregate sales and total domestic employment would have been similarly affected. Industry classification was based on the dominant business code for domestic R&D performance, where available. For companies that did not report business codes, the classification used for sampling was assigned. Excludes data for federally funded research and development centers. The Business Enterprise Research and Development Survey includes only companies with 10 or more domestic employees.

Source(s):
National Center for Science and Engineering Statistics and U.S. Census Bureau, Business Enterprise Research and Development Survey, 2019.

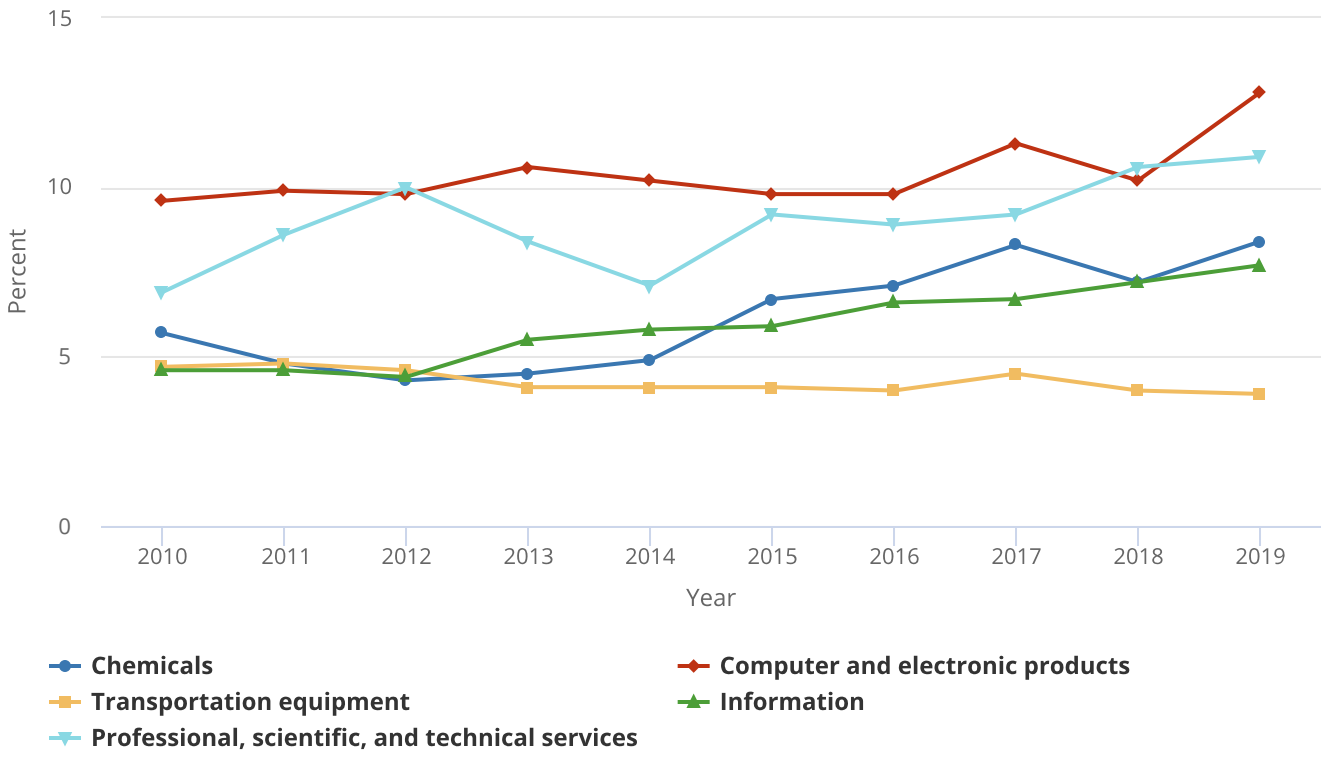
Science and Engineering Indicators

In comparison, R&D intensities for the top five R&D-performing industries were nearly double or more than the average R&D intensity except for transportation equipment manufacturing, which was near the average (**Table RD-10**). The transportation equipment manufacturing industry has a lower R&D intensity compared to other top R&D-performing industries, largely due to its composition. Only one of its underlying industries—the aerospace product and parts manufacturing—has a higher-than-average R&D intensity (6.5% in 2019). Among the detailed industries underlying the top five R&D-performing industries, scientific R&D services had the highest R&D intensity (26.7%). Software publishing, pharmaceuticals and medicines manufacturing, computer and electronic products manufacturing, and computer systems design and related services also had R&D intensities in the double digits.

R&D intensities of the top R&D-performing industries have increased since 2010, except for the transport equipment industry, whose R&D intensity has been relatively stable around 4% (**Figure RD-13**). The largest increase was in PST services, whose R&D intensity was 4 percentage points higher in 2019 compared to 2010, primarily due to an increase of nearly 13 percentage points in the R&D intensity of the scientific R&D services industry.

Figure RD-13

Business R&D intensity, by top R&D-performing industries: 2010–19



Note(s):
Business R&D intensity is the ratio of business R&D expenditures to industry sales. Industry classification is based on the dominant business code for domestic R&D performance, when available. For companies that did not report business codes, the classification used for sampling was assigned. Beginning in survey year 2018, statistics are representative of companies located in the United States that performed or funded $50,000 or more of R&D. The 2010–16 data come from the Business R&D and Innovation Survey and do not include companies with fewer than 5 domestic employees. Data for 2017–18 come from the Business Research and Development Survey, while data for 2019 come from the Business Enterprise Research and Development Survey; both surveys do not include companies with fewer than 10 domestic employees. Data for other industries are available in Table SRD-2.

Source(s):
National Center for Science and Engineering Statistics and U.S. Census Bureau, Business R&D and Innovation Survey (BRDIS), Business Research and Development Survey (BRDS), and Business Enterprise Research and Development Survey.

Science and Engineering Indicators

This distribution across industries differs considerably in terms of the R&D performed by microbusinesses, the businesses with less than 10 employees. Microbusinesses added $5.2 billion to U.S. business R&D in 2019 (**Figure RD-11**). Most microbusiness R&D performance was in the nonmanufacturing sector. This is in stark contrast to the manufacturing emphasis of the R&D performed by larger businesses. (Almost 60% of R&D performance by businesses with 10 or more employees was in the manufacturing sector in 2019.)

Three-quarters of all microbusiness R&D was performed by microbusinesses in the PST services and information services industries (**Figure RD-11**). Within these two industries, scientific R&D services and computer systems design and related services accounted for more than half of microbusiness R&D in 2019.

Sources of Funding for U.S. Business R&D

The R&D performed by businesses with 10 or more employees was funded primarily by companies' own funds (87% in 2019) (**Table RD-11**). Most of the funds came from company units located in the United States (82%), with a small amount (6%) from companies' foreign subsidiaries. The remaining (13%) was R&D performed by the company but paid for by others. The federal government, other domestic companies, and foreign-located companies (foreign parent and unaffiliated companies) each funded about 4% of business R&D performance in 2019.

Table RD-11

Funds spent for business R&D performed in the United States, by source of funds: 2010–19

(Millions of dollars and percent share)

Sector	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Millions of dollars										
U.S. total R&D	406,600	426,215	433,716	454,271	475,969	494,499	521,700	554,012	604,837	666,875
All business R&D[a]	278,977	294,093	302,250	322,528	340,728	355,821	374,685	400,100	441,036	492,956
Paid for by the company	221,706	238,768	247,280	264,913	282,570	296,677	317,731	339,036	377,806	428,968
From company-owned, U.S.-located units	218,187	235,426	242,674	259,908	277,272	289,892	306,611	319,796	354,291	401,851
From foreign-located subsidiaries	3,519	3,342	4,606	5,005	5,298	6,785	11,120	19,240	23,515	27,117
Paid for by others	57,271	55,324	54,970	57,615	58,158	59,144	56,954	61,065	63,230	63,989
Federal	34,199 i	31,309 i	30,621 i	29,362	26,554 i	26,990	23,772	24,277 i	24,685	21,941
Domestically located companies	11,013	11,124	11,624	13,450	13,227	14,595 i	14,239	17,494	19,087	21,461
Foreign-located companies	11,015	12,007	12,093	13,791	17,246	16,317	17,692	18,404	18,333	19,554
Foreign parent[b]	7,102	7,438	8,486	10,445	13,407	12,579	14,766	15,426	15,775	17,563
Unaffiliated companies	3,913	4,569	3,607	3,346	3,839	3,738	2,926	2,978	2,558	1,991
All other organizations[c]	1,046	882	633	1,013	1,131	1,242	1,249	890	1,125	932 - 1,141
In the United States	935	690	491	456	661	616	1149	712	535	774 - 958
Outside the United States	111	192	142	557	470	626	100	178	590	158 - 183
Addenda:										
Funded by domestically located sources[d]	264,334	278,549	285,410	303,176	317,714	332,093	345,771	362,279	398,598	446,116
Funded by foreign-located sources[e]	14,644	15,543	16,841	19,353	23,013	23,729	28,912	37,822	42,438	46,840
Source of funds as a percentage of all business R&D										
All business R&D	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Paid for by the company	79.5	81.2	81.8	82.1	82.9	83.4	84.8	84.7	85.7	87.0

Table RD-11

Funds spent for business R&D performed in the United States, by source of funds: 2010–19

(Millions of dollars and percent share)

Sector	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
From company-owned, U.S.-located units	78.2	80.1	80.3	80.6	81.4	81.5	81.8	79.9	80.3	81.5
From foreign-located subsidiaries	1.3	1.1	1.5	1.6	1.6	1.9	3.0	4.8	5.3	5.5
Paid for by others	20.5	18.8	18.2	17.9	17.1	16.6	15.2	15.3	14.3	13.0
Federal	12.3	10.6	10.1	9.1	7.8	7.6	6.3	6.1	5.6	4.5
Domestically located companies	3.9	3.8	3.8	4.2	3.9	4.1	3.8	4.4	4.3	4.4
Foreign-located companies	3.9	4.1	4.0	4.3	5.1	4.6	4.7	4.6	4.2	4.0
Foreign parent	2.5	2.5	2.8	3.2	3.9	3.5	3.9	3.9	3.6	3.6
Unaffiliated companies	1.4	1.6	1.2	1.0	1.1	1.1	0.8	0.7	0.6	0.4
All other organizations	0.4	0.3	0.2	0.3	0.3	0.3	0.3	0.2	0.3	0.2
In the United States	0.3	0.2	0.2	0.1	0.2	0.2	0.3	0.2	0.1	0.0
Outside the United States	0.0	0.1	0.0	0.2	0.1	0.2	0.0	0.0	0.1	0.0
Addenda:										
Funded by domestically located sources	94.8	94.7	94.4	94.0	93.2	93.3	92.3	90.5	90.4	90.5
Funded by foreign-located sources	5.2	5.3	5.6	6.0	6.8	6.7	7.7	9.5	9.6	9.5

i = more than 50% of the estimate is a combination of imputation and reweighting to account for nonresponse.

[a] Includes companies located in the United States that performed or funded R&D. Data in this table represent an aggregate of all industries in the North American Industry Classification System codes 21–33 and 42–81.

[b] Parent companies of foreign-owned subsidiaries located in the United States.

[c] Includes U.S. state government agencies and laboratories, foreign agencies and laboratories, and all other organizations located inside and outside the United States.

[d] Consists of funds paid for by company-owned, U.S.-located units; domestically located companies; U.S. federal government; and all other organizations in the United States.

[e] Consists of funds paid by foreign-located subsidiaries, foreign parent, unaffiliated companies, and all other organizations outside of the United States.

Note(s):
Detail may not add to total because of rounding. Industry classification was based on the dominant business code for domestic R&D performance, where available. For companies that did not report business codes, the classification used for sampling was assigned. This table excludes data for federally funded R&D centers. Data for 2010–16 come from the National Center for Science and Engineering Statistics' (NCSES's) annual Business Research and Development and Innovation Survey, which covered all publicly or privately held companies with 5 or more employees. Data for 2017

and 2018 come from NCSES's annual Business Research and Development Survey, which covers all publicly or privately held companies with 10 or more employees. Data for 2019 come from NCSES's annual Business Enterprise Research and Development Survey, which also covers all publicly or privately held companies with 10 or more employees. An estimate range may be displayed in place of a single estimate to avoid disclosing operations of individual companies.

Source(s):
National Center for Science and Engineering Statistics, Business Research and Development and Innovation Survey (BRDIS), Business Research and Development Survey (BRDS), Business Enterprise Research and Development Survey (BERD).

Science and Engineering Indicators

The most notable change in the sources of funds for the R&D performed by these businesses since 2010 has been the declining role of federal funding, falling from over 12% in 2010 to about 4% in 2019 (**Table RD-11**). The decline in federal funding coincides with an increase in funding by companies' own funds from both domestic units and foreign subsidiaries. During this period, funding from companies' domestic units and foreign subsidiaries increased by more than 3 percentage points and 4 percentage points, respectively.

Funding from all domestically located sources accounted for just over 90% of the U.S. business R&D performed by businesses with 10 or more employees in 2019 (**Table RD-11**). Foreign-located sources accounted for a substantially smaller but growing share of business R&D. Since 2010, the funding from domestic sources declined by more than 4 percentage points, from about 95% in 2010 to about 90% in 2019, while funding from foreign sources increased from 5% to almost 10%.

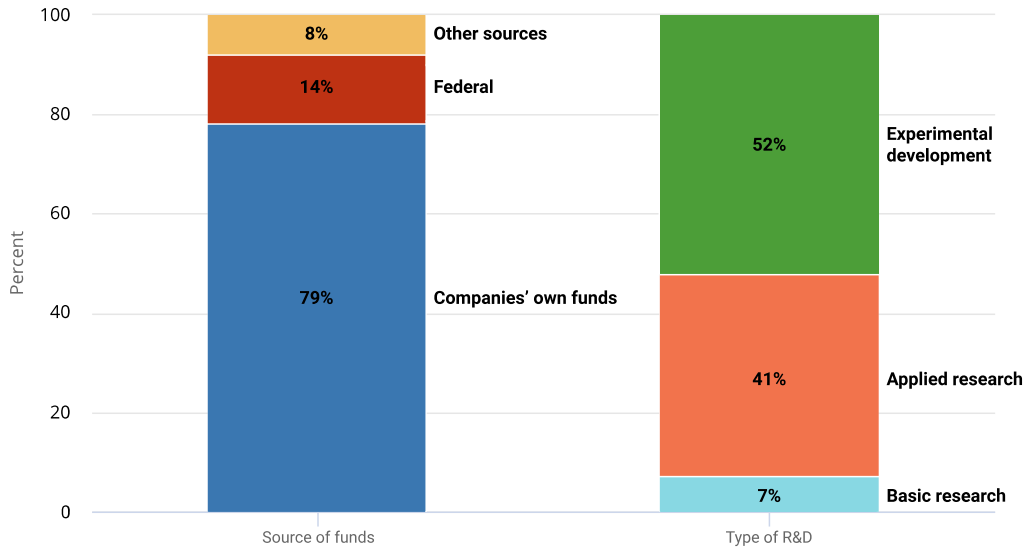
There are also notable differences in sources of funds for the R&D performed by the top R&D-performing industries (**Table RD-9**). In 2019, companies' own funds almost exclusively funded R&D performance in the information sector and most of the R&D performed in the chemicals manufacturing, computer and electronic products, and transportation equipment industries.

The federal government funded over 20% of the R&D performed in transportation equipment manufacturing, including nearly half of the R&D performance in aerospace product and parts manufacturing. Almost half of the funding for the R&D performance in PST services came from external sources, with 28% coming from other domestic businesses. Within PST services, a substantial amount (63%) of R&D performance in scientific R&D services was funded by other domestic businesses.

The business R&D performed by microbusinesses was also funded primarily from companies' own funds (79% in 2019) (**Figure RD-14**). Microbusinesses, however, received larger funding support from the federal government compared to other businesses (14% vs. 4%). Almost three-fourths (74%) of all federal government R&D funding to microbusinesses in 2019 went to companies in scientific R&D services (NCSES ABS, data year 2019). The remaining 8% of microbusiness R&D performance was funded from other sources, including other companies, nonfederal governments, and nonprofit and other organizations.

Figure RD-14

Microbusiness R&D performance, by source of funds and type of R&D: 2019



Source(s):
National Center for Science and Engineering Statistics and U.S. Census Bureau, special tabulations (2022) of the Annual Business Survey (ABS), data year 2019.

Science and Engineering Indicators

Company Size and U.S. Business R&D

The distribution of R&D performance by company size class has not changed much in recent years. Large companies with 250 or more employees performed about 85%–90% of business R&D in any given year from 2010 to 2019 (**Table RD-12**). Among these, the largest companies—those with 25,000 or more employees—performed over a third of business R&D each year. Medium companies—those with 50–249 employees—performed, on average, about 7%–8% of annual business R&D. The remaining 2%–8% are attributable to small companies with fewer than 50 employees, including microbusinesses.

Table RD-12

Funds spent for business R&D performed in the United States, by size of company: 2010–19

(Millions of dollars and percent share)

Size of company (number of domestic employees)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	Millions of dollars									
All business domestic R&D[a]	278,977	294,092	302,251	322,528	340,728	355,821	379,529	405,792	445,563	498,175
Micro companies[b]										
1–4	NA	NA	NA	NA	NA	NA	4,843	NA	1,891	2,350
5–9	3,851	4,202	2,926 i	3,402 i	3,295 i	2,988 i	1,581 i	NA	2,636	2,869
1–9	NA	NA	NA	NA	NA	NA	NA	5,691	4,527	5,219
Small companies										
10–24[c]	8,722	6,779	6,915 i	6,895 i	7,177 i	NA	NA	NA	NA	NA

Table RD-12

Funds spent for business R&D performed in the United States, by size of company: 2010–19

(Millions of dollars and percent share)

Size of company (number of domestic employees)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
25–49	8,624	10,861	7,195 i	7,941 i	8,428 i	NA	NA	NA	NA	NA
10–19[c]	NA	NA	NA	NA	NA	5,680 i	4,958 i	3,311	4,390	5,501
20–49[c]	NA	NA	NA	NA	NA	10,249 i	9,662 i	9,435	11,252	12,418
Medium companies										
50–99	8,855	9,468	9,182 i	8,910	10,178 i	11,509	9,298	10,141	12,321	14,021
100–249	11,866	12,528	12,480	13,666	13,492	13,602	14,875	17,216	18,547	19,793
Large companies										
250–499	10,283	12,955	11,264	12,189	12,203	13,553	13,092	14,103	19,645	18,883
500–999	10,116	10,027	11,484	12,002	13,262	15,217	14,450	17,871	17,657	23,969
1,000–4,999	48,227	50,485	50,691	55,517	57,551	58,094	63,971	65,112	68,578	75,671
5,000–9,999	27,463	24,951	30,483	31,514	38,202	38,838	40,633	40,198	45,337	50,811
10,000–24,999	41,835	49,214	49,493	51,218	54,445	59,328	65,594	73,485	84,420	88,263
25,000 or more	99,133	102,623	110,138	119,275	122,495	126,763	136,571	149,227	158,889	183,626
Percentage of all business R&D										
All business domestic R&D[a]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Micro companies[b]										
1–4	NA	NA	NA	NA	NA	NA	1.3	NA	0.4	0.5
5–9	1.4	1.4	1.0	1.1	1.0	0.8	0.4	NA	0.6	0.6
1–9	NA	NA	NA	NA	NA	NA	NA	1.4	1.0	1.0
Small companies										
10–24[c]	3.1	2.3	2.3	2.1	2.1	NA	NA	NA	NA	NA
25–49	3.1	3.7	2.4	2.5	2.5	NA	NA	NA	NA	NA
10–19[c]	NA	NA	NA	NA	NA	1.6	1.3	0.8	1.0	1.1
20–49[c]	NA	NA	NA	NA	NA	2.9	2.5	2.3	2.5	2.5
Medium companies										
50–99	3.2	3.2	3.0	2.8	3.0	3.2	2.4	2.5	2.8	2.8
100–249	4.3	4.3	4.1	4.2	4.0	3.8	3.9	4.2	4.2	4.0
Large companies										
250–499	3.7	4.4	3.7	3.8	3.6	3.8	3.4	3.5	4.4	3.8
500–999	3.6	3.4	3.8	3.7	3.9	4.3	3.8	4.4	4.0	4.8
1,000–4,999	17.3	17.2	16.8	17.2	16.9	16.3	16.9	16.0	15.4	15.2
5,000–9,999	9.8	8.5	10.1	9.8	11.2	10.9	10.7	9.9	10.2	10.2
10,000–24,999	15.0	16.7	16.4	15.9	16.0	16.7	17.3	18.1	18.9	17.7
25,000 or more	35.5	34.9	36.4	37.0	36.0	35.6	36.0	36.8	35.7	36.9

i = more than 50% of value imputed; NA = not available.

[a] R&D performed by companies in the domestic United States. Includes industries in NAICS 21–33, 42–81.

[b] Data for 2010–15 come from the National Center for Science and Engineering Statistics' (NCSES's) annual Business Research and Development and Innovation Survey (BRDIS), which covered all publicly or privately held companies with 5 or more employees. Data for 2016 included the BRDIS data for that year plus the data from the 2016 Business R&D and Innovation Survey–Microbusiness, which collected statistics on the R&D activities of companies with 1–4 employees ($4.8 billion in 2016). Data for 2017 and 2018 come from NCSES's annual Business Research and Development Survey, which covers all publicly or privately held companies with 10 or more employees, plus the Annual Business Surveys (ABS) for 2017 and 2018, which collected statistics on the R&D activities of businesses with 1–9 employees ($5.7 billion in 2017 and $4.5 billion in 2018). Data for 2019 come from NCSES's annual Business Enterprise Research and Development Survey, which covers all publicly or privately held companies with 10 or more employees, plus the ABS for 2019, which collected statistics on the R&D activities of businesses with 1–9 employees ($5.2 billion in 2019).

[c] Employee size categories have been revised to match international classifications starting in 2015.

Note(s):
Detail may not add to total because of rounding. This table excludes data for federally funded R&D centers.

Source(s):
National Center for Science and Engineering Statistics, Business Research and Development and Innovation Survey (BRDIS), Business Research and Development Survey (BRDS), Business Enterprise Research and Development Survey (BERD), Business Research and Development and Innovation Survey–Microbusiness (BRDI-M), Annual Business Survey (ABS), data years 2017 and 2018, and special tabulations (2022) of the ABS, data year 2019.

Science and Engineering Indicators

There have been changes over this period in how the business R&D surveys have defined and included small companies.[21] Through 2016, the reference population for BRDIS excluded companies with fewer than 5 employees. The Business R&D and Innovation Survey–Microbusiness (BRDI-M) collected one-time data on these companies (1–4 employees) for 2016.[22] Starting in 2017, the reference population for BRDS (and its successor BERD) excluded companies with fewer than 10 employees. The ABS was established to collect—among other business data—data on R&D activities of microbusinesses (companies with 1–9 employees), starting with reference year 2017.

Despite stability in distribution of R&D performance by company size class, the R&D performance for each size class has varied over time. A recent NCSES analysis of R&D performance by company size class showed, for instance, that R&D performance by larger-sized companies rebounded from the Great Recession considerably better than small and medium companies whose R&D performance in 2015 had yet to recover to 2009 levels (Anderson and Kindlon 2019).

U.S. Business R&D, by Type

Businesses vary in their relative efforts to perform different types of R&D. Experimental development and applied research have historically dominated R&D performance in the business sector. In 2019, 78% of the R&D performed by businesses with 10 or more employees was in experimental development, accounting for 90% of U.S. experimental development across all R&D-performing sectors (**Table RD-13**). Applied research was a much smaller share (15%) of the R&D performed by these businesses but accounted for more than half (56%) of U.S. applied research. Similarly, basic research was a small share of business R&D (7%) but accounted for almost a third (31%) of U.S. basic research.

Table RD-13

Funds spent for business R&D performed in the United States, by type of R&D: 2010–19

(Millions of dollars and percent share)

Type of R&D	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Millions of dollars										
All U.S. R&D	406,600	426,215	433,716	454,271	475,969	494,499	521,700	554,012	604,837	666,875
Basic research	76,388	73,552	73,843	79,137	82,769	84,273	85,689	88,696	96,043	102,874
Applied research	79,017	81,891	86,822	88,158	91,771	97,249	110,484	114,069	119,837	132,021
Experimental development	251,195	270,772	273,051	286,976	301,428	312,977	325,528	351,248	388,957	431,981
All business R&D[a]	278,977	294,093	302,250	322,528	340,728	355,821	374,685	400,100	441,036	492,956
Basic research	16,371	13,020	13,293	19,508	21,936	21,792	24,644	24,829	28,980	32,239
Applied research	44,906	47,186	50,755	51,014	53,415	56,472	61,020	62,132	65,222	74,031
Experimental development	217,699	233,886	238,202	252,007	265,377	277,558	289,021	313,139	346,834	386,686
Distribution of total U.S. R&D and business R&D, by type of R&D (%)										
All U.S. R&D	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Basic research	18.8	17.3	17.0	17.4	17.4	17.0	16.4	16.0	15.9	15.4
Applied research	19.4	19.2	20.0	19.4	19.3	19.7	21.2	20.6	19.8	19.8
Experimental development	61.8	63.5	63.0	63.2	63.3	63.3	62.4	63.4	64.3	64.8
All business R&D[a]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Basic research	5.9	4.4	4.4	6.0	6.4	6.1	6.6	6.2	6.6	6.5
Applied research	16.1	16.0	16.8	15.8	15.7	15.9	16.3	15.5	14.8	15.0

Table RD-13

Funds spent for business R&D performed in the United States, by type of R&D: 2010–19

(Millions of dollars and percent share)

Type of R&D	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Experimental development	78.0	79.5	78.8	78.1	77.9	78.0	77.1	78.3	78.6	78.4
Business share of total U.S. R&D and each type of R&D (%)										
All business R&D[a]	68.6	69.0	69.7	71.0	71.6	72.0	71.8	72.2	72.9	73.9
Basic research	21.4	17.7	18.0	24.7	26.5	25.9	28.8	28.0	30.2	31.3
Applied research	56.8	57.6	58.5	57.9	58.2	58.1	55.2	54.5	54.4	56.1
Experimental development	86.7	86.4	87.2	87.8	88.0	88.7	88.8	89.2	89.2	89.5

[a] Includes companies located in the United States that performed or funded R&D. Data in this table represent an aggregate of all industries in the North American Industry Classification System codes 21–33 and 42–81.

Note(s):
Detail may not add to total because of rounding. Industry classification is based on the dominant business code for domestic R&D performance, where available. For companies that did not report business codes, the classification used for sampling was assigned. Beginning in survey year 2018, statistics are representative of companies located in the United States that performed or funded $50,000 or more of R&D. Data for 2010–16 come from the National Center for Science and Engineering Statistics' (NCSES's) annual Business Research and Development and Innovation Survey, which covered all publicly or privately held companies with 5 or more employees. Data for 2017 and 2018 come from NCSES's annual Business Research and Development Survey, which covers all publicly or privately held companies with 10 or more employees. Data for 2019 come from NCSES's annual Business Enterprise Research and Development Survey, which also covers all publicly or privately held companies with 10 or more employees. The total U.S. R&D data come from National Patterns of R&D Resources (2019–20 edition).

Source(s):
National Center for Science and Engineering Statistics, Business Research and Development and Innovation Survey (BRDIS), Business Research and Development Survey (BRDS), Business Enterprise Research and Development Survey (BERD), and National Patterns of R&D Resources (2019–20 edition).

Science and Engineering Indicators

The applied research and experimental development performed by businesses with 10 or more employees has increased steadily since 2010 (**Table RD-13**). Business basic research declined earlier in the period but has since recovered. The business share of the U.S. total basic research has increased from about 20% early in the period to 31% in 2019. While business-performed basic research accounts for an increasing share of U.S. basic research, basic research as a share of U.S. total R&D has been on a path of decline (from 19% in 2010 to 15% in 2019). This is largely a result of the faster growth in business R&D compared to other R&D-performing sectors, most of which goes to experimental development.

The distribution of R&D performance by R&D type varies across industries. More than 40% of business basic research performed by businesses with 10 or more employees in 2019 was in chemicals manufacturing, including manufacturing of pharmaceuticals, and about a fourth was in information and PST services (Table SRD-4). A large share (26%) of business applied research was also in chemicals manufacturing, including pharmaceuticals. Nearly 45% of business experimental development was in information (25%) and computer and electronic products (19%) industries. Other top R&D-performing industries also had sizable shares of all three types of business R&D.

By funding source, the most notable trend in funding of different types of R&D performed by businesses with 10 or more employees is the decline in federal funding. This decline is more evident for business experimental development (Table SRD-3). Federal funding accounted for 4% of business experimental development funding in 2019, compared to 13% in 2010.

For microbusinesses, just over half (52%) of R&D performance in 2019 was on experimental development, while 41% was on applied research, and 7% was on basic research (**Figure RD-14**). Compared to other businesses, microbusinesses perform relatively less experimental development and more applied research.

Cross-National Comparisons of Business R&D

This section compares the industrial composition of business R&D in the United States with that of other major R&D performing countries—France, Germany, the United Kingdom, China, Japan, and South Korea. Corresponding statistics for India are not presently available. The data come from the OECD's Analytical Business Enterprise R&D (ANBERD) database.

The international industry data are classified based on the fourth revision of the International Standard Industrial Classification of All Economic Activities (ISIC, Rev.4). The ISIC differs somewhat from NAICS, used elsewhere in this report to analyze U.S. trends.[23] The results from the analysis for the United States presented in this section, however, are similar to those reported earlier in this report based on NAICS.

Only industries with comparatively higher levels of annual R&D performance are included in the analysis.[24] The analysis focuses on comparisons of industry shares of business R&D performance across countries for the year 2018 or the most recent year of available data; the associated dollar amounts are listed in **Table RD-14**. All amounts and calculations are in current PPP dollars.

Table RD-14

Business expenditures for R&D, by selected countries and top R&D performing industries: 2018 or most recent year

(Millions of U.S. PPP dollars and percent of total business enterprise)

Industry	ISIC, Rev.4		United States (2018)	France (2017)	Germany (2018)	United Kingdom (2018)	China (2018)	Japan (2018)	South Korea (2018)
	Section	Division							
Millions of U.S. PPP dollars									
Total business enterprise	A - U	1 - 99	441,036	42,895	97,872	36,644	360,369	137,230	79,511
Manufacturing	C	10 - 33	274,075	20,869	83,583	14,293	326,664	118,750	70,643
Chemicals and chemical products		20	9,545	1,315	5,692	563	23,941	8,070	4,109
Pharmaceuticals, medicinal chemical and botanical products		21	74,592	1,079	7,094	658	13,741	13,545	1,825
Computer, electronic, and optical products		26	83,697	4,886	11,240	1,692	59,214	26,708	41,075
Motor vehicles, trailers, and semi-trailers		29	25,586	3,124	36,753	4,475	31,040	35,775	9,748
Other transport equipment		30	27,044	3,780	2,753	2,543	9,482	1,219	911
Air and spacecraft and related machinery		303	24,291	3,412	2,317	2,301	NA	792	414
Total services	G - U	45 - 99	164,122	20,823	13,700	21,571	NA	16,448	7,202
Information and communication	J	58 - 63	110,272	5,881	4,891	5,684	NA	5,795	3,552
Publishing activities		58	32,770	1,522	NA	195	NA	15	2,348
Software publishing		582	32,639	1,499	NA	82	NA	NA	2,286
Computer programming, consultancy, and related activities		62	15,923	2,829	4,510	3,206	NA	2,855	476
Professional, scientific, and technical activities	M	69 - 75	28,937	11,087	7,568	11,832	NA	9,069	1,904
Scientific research and development		72	20,185	5,038	4,150	8,284	NA	8,407	796
Percent of total business enterprise									
Total business enterprise	A - U	1 - 99	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Manufacturing	C	10 - 33	62.1	48.7	85.4	39.0	90.6	86.5	88.8
Chemicals and chemical products		20	2.2	3.1	5.8	1.5	6.6	5.9	5.2
Pharmaceuticals, medicinal chemical and botanical products		21	16.9	2.5	7.2	1.8	3.8	9.9	2.3
Computer, electronic, and optical products		26	19.0	11.4	11.5	4.6	16.4	19.5	51.7

Table RD-14

Business expenditures for R&D, by selected countries and top R&D performing industries: 2018 or most recent year

(Millions of U.S. PPP dollars and percent of total business enterprise)

Industry	ISIC, Rev.4		United States (2018)	France (2017)	Germany (2018)	United Kingdom (2018)	China (2018)	Japan (2018)	South Korea (2018)
	Section	Division							
Motor vehicles, trailers, and semi-trailers		29	5.8	7.3	37.6	12.2	8.6	26.1	12.3
Other transport equipment		30	6.1	8.8	2.8	6.9	2.6	0.9	1.1
Air and spacecraft and related machinery		303	5.5	8.0	2.4	6.3	NA	0.6	0.5
Total services	G - U	45 - 99	37.2	48.5	14.0	58.9	NA	12.0	9.1
Information and communication	J	58 - 63	25.0	13.7	5.0	15.5	NA	4.2	4.5
Publishing activities		58	7.4	3.5	NA	0.5	NA	0.0	3.0
Software publishing		582	7.4	3.5	NA	0.2	NA	NA	2.9
Computer programming, consultancy, and related activities		62	3.6	6.6	4.6	8.7	NA	2.1	0.6
Professional, scientific, and technical activities	M	69 - 75	6.6	25.8	7.7	32.3	NA	6.6	2.4
Scientific research and development		72	4.6	11.7	4.2	22.6	NA	6.1	1.0

NA = not available.

ISIC, Rev.4 = International Standard Industrial Classification, 4th Revision; PPP = purchasing power parity.

Note(s):
Detail may not add to total because of rounding. Industry classifications for all countries are based on main activity. The U.S. business R&D data are from the U.S. Business Research and Development survey 2018 (crosswalked to the ISIC, Rev.4, classifications). In general, the table includes industries with annual R&D expenditures of $10 billion or more (i.e., each country's largest R&D performers). See the Organisation for Economic Co-operation and Development's Analytical Business Enterprise Research and Development database for a more detailed set of industries by country.

Source(s):
National Center for Science and Engineering Statistics, Business Research and Development Survey (BRDS); Organisation for Economic Co-operation and Development, Analytical Business Enterprise Research and Development (ANBERD) database, http://www.oecd.org/sti/inno/anberdanalyticalbusinessenterpriseresearchanddevelopmentdatabase.htm, accessed 22 December 2021.

Science and Engineering Indicators

Manufacturing is the focus of business R&D performance in many, but not all, of the top R&D-performing countries. The manufacturing sector accounted for more than half of the total business R&D in the United States (62%) in 2018 (**Table RD-14**). Germany (85%), China (91%), Japan (87%), and South Korea (89%) had even higher manufacturing shares of business R&D compared to the United States.

France and the United Kingdom were exceptions to the manufacturing emphasis. In the United Kingdom, the services sector accounted for the larger share (59%) of business R&D. In France, R&D performance was virtually equally split between the manufacturing and services sectors.

Within manufacturing, R&D performance was concentrated in a few industries. In the United States, the computer, electronic, and optical products (ISIC 26) and the pharmaceuticals, medicinal chemical, and botanical products (ISIC 21) were the two largest R&D-performing industries, with 19% and 17% industry shares, respectively, of U.S. total business R&D. Air and spacecraft and related machinery (ISIC 30) and motor vehicles, trailers, and semi-trailers (ISIC 29) followed, each with 6% industry shares of U.S. total business R&D.

Motor vehicles, trailers, and semi-trailers and computer and electronic and optical products were the two largest R&D-performing industries in Germany, Japan, South Korea, and China. Chemicals and chemical products (ISIC 20) followed as the next-largest R&D-performing industry in China and South Korea and performed a sizable share of business R&D in Japan and Germany. The pharmaceuticals industry was among the three largest R&D-performing industries in Japan and performed a sizable share of business R&D in Germany. The air and spacecraft industry performed a sizable share of business R&D in France and the United Kingdom.

The services sector (ISIC 45–99) is an important performer of business R&D in some of the top R&D-performing countries. The services sector accounted for more than a third of U.S. business R&D in 2018. Within services, business R&D performance was concentrated in two industries: information and communication (ISIC 58–63), and PST activities (ISIC 69–75) (**Table RD-14**). A quarter of U.S. business R&D was in information and communication, and 7% was in PST activities.

This sector also led business R&D performance in the United Kingdom (59%) and performed a notable share of business R&D in France (49%). In the United Kingdom, 32% of business R&D was in PST activities, and 16% was in information and communication. Similarly, 26% of business R&D in France was in PST activities, and 14% was in information and communication.

Recent Trends in Federal Support for U.S. R&D

This section provides a more detailed account of the federal government's present roles as performer and as funder of the U.S. R&D enterprise. At the time of this report, the most recent fiscal year for which complete and final funding data are available is FY 2020.[25] Data cited for FY 2021 are preliminary and may be revised in a subsequent survey edition. The trend comparisons discussed refer mainly to the period of FYs 2008–21. There is also a concluding discussion that compares indicators of U.S. federal R&D with those of the largest other R&D-performing countries.

The data discussed throughout this section are the obligations of federal agencies for R&D and R&D plant by federal fiscal year. Obligations represent the monetary amount of orders placed, contracts awarded, services received, and other similar transactions, regardless of when the funds were appropriated and when future payments may be required. Obligations typically provide a better measure of actual agency spending than the budget appropriations granted to agencies by Congress in advance of agency spending actions.

Total of Federal Funding for R&D and for Major Agencies

Currently, 33 federal agencies (14 departments, 19 independent agencies) perform or fund R&D in support of their mission. Over the years, one of the federal government's most significant roles in supporting U.S. science and engineering (S&E) has been to provide a regular stream of funding for R&D performed by both federal entities (agency intramural laboratories and facilities and FFRDCs) and external, nonfederal organizations, such as businesses, academic institutions, state and local governments, and nonprofit organizations.

For many years, most all of the yearly federal R&D funding total is accounted for by a relatively small group of departments and agencies: the Department of Defense (DOD), the Department of Health and Human Services (HHS, which includes the National Institutes of Health [NIH]), the Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), the Department of Agriculture (USDA), the Department of Commerce (DOC), the Department of Veterans Affairs (VA), and the Department of Transportation (DOT) (**Table RD-15**).

Table RD-15

Federal obligations for R&D and R&D plant, by agency: FYs 2008–21

(Millions of dollars)

Agency	2008	2009	2010	2011	2012	2013	2014	2015	2016[a]	2017	2018	2019	2020	2021[b]
All agencies	129,049.5	144,758.1	146,967.8	139,703.3	140,670.2	127,625.5	132,779.0	131,578.3	118,273.8	121,626.6	133,277.5	146,800.7	173,552.9	185,408.1
Department of Defense	71,996.6	75,973.7	73,623.9	75,328.2	73,973.6	63,654.7	65,128.6	61,683.0	44,926.7	45,163.8	53,444.0	59,389.2	67,006.8	69,456.0
Department of Health and Human Services	29,700.7	35,735.9	37,616.9	30,928.0	31,335.8	29,512.8	30,799.1	30,425.5	32,366.8	33,901.8	37,115.8	39,434.2	61,774.8	71,189.0
Department of Energy	8,990.3	11,562.2	11,644.9	10,680.4	10,635.2	10,397.1	11,296.3	12,343.0	13,343.2	13,583.9	14,894.1	16,621.9	15,778.0	17,241.2
National Aeronautics and Space Administration	5,847.1	5,957.6	8,691.3	8,429.0	10,758.3	10,494.3	10,880.6	11,413.1	12,461.7	12,638.1	10,813.9	13,616.4	10,573.6	8,833.5
National Science Foundation	4,506.4	6,924.8	6,073.4	5,536.6	5,705.4	5,328.5	5,800.2	5,989.7	6,022.3	5,945.7	6,358.0	6,648.3	6,792.5	6,938.9
Department of Agriculture	2,246.0	2,344.7	2,615.4	2,376.9	2,187.6	2,031.2	2,269.0	2,352.0	2,380.4	2,575.2	2,522.7	2,666.1	3,433.5	2,769.7
Department of Commerce	1,196.4	1,533.4	1,683.2	1,308.9	1,230.7	1,293.9	1,567.8	1,519.4	1,635.6	1,847.1	1,832.3	1,999.0	1,980.9	2,432.7
Department of Veterans Affairs	480.0	510.0	563.0	612.9	614.8	639.0	588.8	661.6	695.2	682.3	1,349.0	1,507.9	1,565.1	1,689.4
Department of Transportation	825.2	846.2	929.2	861.8	936.1	875.8	847.7	884.5	961.5	987.0	1,076.6	1051.7	1,224.5	1,180.6
Department of the Interior	645.3	738.8	728.0	716.5	742.7	717.3	762.4	808.7	859.9	868.1	768.6	831.5	844.4	891.1
Department of Homeland Security	1,056.8	983.6	1,131.8	1,127.5	832.2	718.8	943.8	1,645.2	689.2	869.9	913.1	648.5	507.5	541.0
Environmental Protection Agency	532.0	552.8	572.3	581.7	581.1	529.7	538.0	520.7	513.3	498.4	492.1	490.0	493.0	524.1
Patient-Centered Outcomes Research Trust Fund	na	na	na	41.1	41.1	334.4	282.6	152.1	114.9	883.9	491.7	578.4	469.7	390.9
Smithsonian Institution	188.0	226.7	213.0	248.7	246.2	240.3	230.9	229.0	235.0	240.5	260.6	269.0	276.0	281.0
Department of Education	328.1	322.4	362.8	346.1	338.0	309.9	322.0	251.3	244.4	261.8	266.2	235.8	240.1	379.2
Agency for International Development	123.8	160.1	84.3	119.2	77.4	125.5	59.9	212.2	192.8	192.2	166.6	220.6	194.3	194.3
Department of Justice	114.5	103.4	125.4	102.3	85	118.7	160.5	149.7	208.0	126.9	106.6	121.2	96.4	99.5
Social Security Administration	54.1	67.9	63.0	53.0	64.9	56.7	59.6	58.9	129	109.5	71.6	146.2	69.7	129.4
All other agencies	218.2	213.9	246.0	304.5	284.1	246.9	241.2	278.7	293.9	250.5	334.0	324.8	232.1	246.6

na = not applicable.

[a] Beginning in FY 2016 (and continuing in subsequent years), agency reports of obligations for R&D reflect the application of a definition for development that is narrowed to experimental development. This revision was introduced to align federal R&D budget formulation consistent with the Office of Management and Budget's Circular A-11, Section 84. This change in definition applies to all agencies, but the predominant impact is that the Department of Defense's (DOD's) Operational Systems Development (Budget Activity 7) is no longer included as development. DOD Operational Systems Development was about $24.6 billion in FY 2016, $26.0 billion in FY 2017, $26.7 billion in FY 2018, $35.2 billion in FY 2019, and $37.3 billion in FY 2020. Accordingly, the All agencies and DOD R&D obligations totals listed above for FYs 2016–21 are not directly comparable with those for FY 2015 and earlier years.

[b] The data for FY 2021 are preliminary and may later be revised. Obligations for FYs 2020 and 2021 include the additional funding provided by supplemental COVID-19 related appropriations in these years (i.e., the Coronavirus Aid, Relief, and Economic Security Act of March 2020, the American Rescue Plan Act of March 2021, and several other enacted spending authorizations in these fiscal years).

Note(s):
Table lists (in general) agencies with R&D and R&D plant obligations greater than $100 million in FY 2020. Agency rankings are based on the FY 2020 data. All other agencies includes the Department of Housing and Urban Development, Department of Labor, Department of State, Department of the Treasury, Administrative Office of the U.S. Courts, Appalachian Regional Commission, Consumer Product Safety Commission, Federal Communications Commission, Federal Trade Commission, Library of Congress, National Archives and Records Commission, Nuclear Regulatory Commission, Tennessee Valley Authority, RESTORE Act Centers, U.S. Agency for Global Media, and U.S. Postal Service.

Source(s):
National Center for Science and Engineering Statistics, Survey of Federal Funds for Research and Development, Volume 70, FYs 2020–21.

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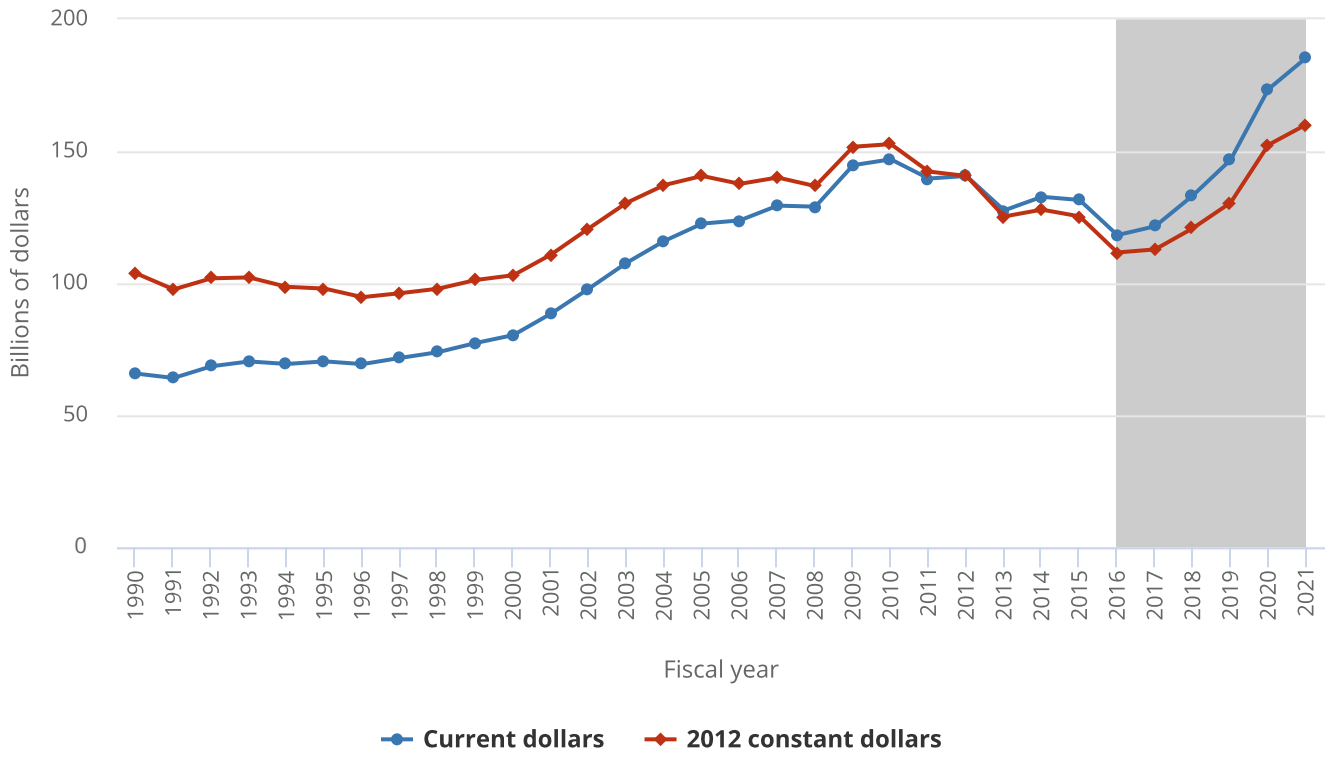
In FY 2020, the nine agencies mentioned above each obligated near or well above $1 billion (current dollars) annually on R&D and R&D plant (**Table RD-15**). These nine agencies accounted for 98% of the federal R&D and R&D plant total that year. Another four agencies obligated funding in the $500 million–$900 million range: the Department of the Interior, the Department of Homeland Security, the Environmental Protection Agency, and the Patient-Centered Outcomes Research Trust Fund.

The level of overall federal support for R&D (including for both R&D conduct and R&D plant) has, for the most part, increased annually since the early 1950s (**Figure RD-15**; Table SRD-5).[26] The $2 billion–$5 billion obligated to R&D in the mid-1950s increased to around $130 billion in FYs 2007 and 2008. The levels moved higher still, to what were then historical peaks in FYs 2009 and 2010, largely a result of the $18.7 billion of incremental funding for R&D authorized by the American Recovery and Reinvestment Act of 2009 (ARRA) (**Figure RD-15**).

Figure RD-15

Federal obligations for R&D and R&D plant, current and constant dollars: FYs 1990–2021



Note(s):
The data for FY 2021 are preliminary and may later be revised. Data for FYs 2009 and 2010 include obligations from the additional federal R&D funding appropriated by the American Recovery and Reinvestment Act of 2009. Beginning in FY 2016, agency reports of obligations for R&D incorporated the Office of Management and Budget's narrowed definition of *development* (Circular A-11, Section 84). This change in definition applies to all agencies, but the main impact has been that Department of Defense's (DOD's) Operational Systems Development (Budget Activity 7) is no longer included as development. DOD Operational Systems Development was about $24.6 billion in FY 2016 and $26.0 billion in FY 2017. Accordingly, the federal obligations totals for FYs 2016–21 (shaded in the graphic) are not directly comparable with those for FY 2015 and earlier years. The data for FYs 2020 and 2021 include the additional funding provided by supplemental COVID-19 related appropriations in these years.

Source(s):
National Center for Science and Engineering Statistics, Survey of Federal Funds for Research and Development, Volume 70, FYs 2020–21.

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A less favorable trend ensued in FYs 2011–15, however, with the level of federal R&D funding generally dropping over that period (**Figure RD-15**). Adjusted for inflation, the FY 2015 level was 18% below the FY 2010 level (Table SRD-5). Some of this post–FY 2010 drop in federal R&D funding reflected a normal waning of the incremental funding provided by ARRA, which showed up as R&D obligations mainly in FYs 2009 and 2010. Some of the decreased funding can also be attributed to the slow post–Great Recession expansion of the U.S. economy. But, in addition, emerging pressures on federal discretionary spending and the more challenging policy setting for federal budget decisions in 2011 and after also played roles. These factors all took a toll on the federal funding approved for R&D as part of the larger federal budget picture.[27]

The large, continued drop in the FY 2016 level of funding may appear to be a continuation of the substantial falloff of federal funding starting in FY 2011, but it mainly reflects an important technical change in the official data. Beginning in FY 2016, federal agencies reported R&D spending using a narrowed definition of *development* adopted by the Office of Management and Budget (OMB) (and consistent with international standards).[28] As issued, this refined definition covered all agencies. But, as a practical matter, only a few agencies experienced noticeable effects: NASA, to a modest degree, with a decline in reported development (and, correspondingly, the R&D total) of $2 billion in FY 2016 and similar thereafter, but DOD, in a rather large way, with $25 billion of formerly reported development excluded in FY 2016 and somewhat larger amounts in more recent years. No other agencies indicated that the change in OMB's official definition of R&D resulted in revisions to their reported R&D totals.

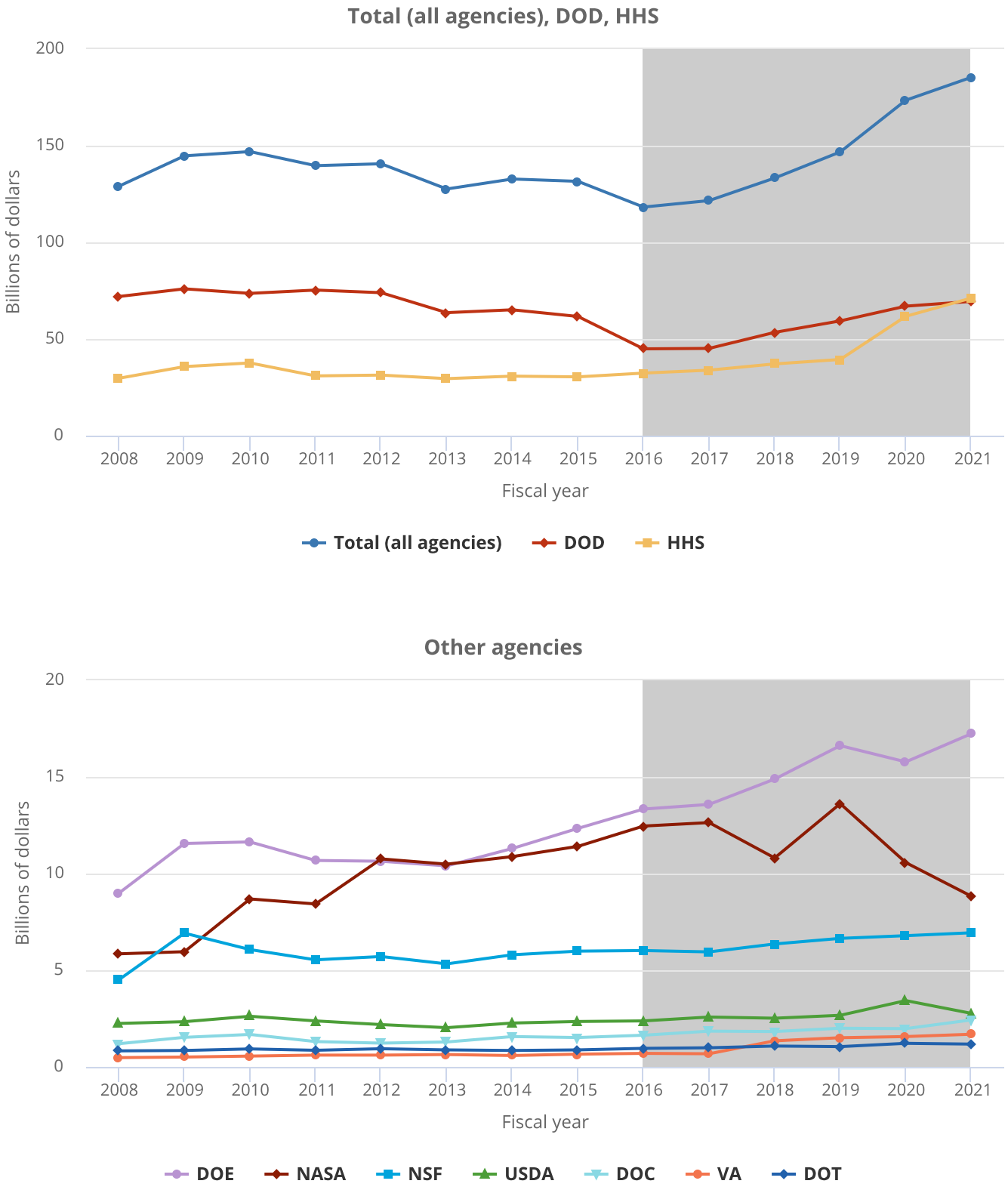
A trend of annual funding increases returned in FYs 2017–21, although now starting from a lower baseline, given the adoption of the revised development definition in FY 2016. The $147 billion of R&D obligations reported in FY 2019 returned to the prior peak in FY 2010, which was then exceeded by the $174 billion in FY 2020 and $185 billion (preliminary) in FY 2021 (**Figure RD-15**). When adjusted for inflation, the FY 2019 level was still well below the FY 2010 peak; the FY 2020 level nearly matched that of FY 2010, however, and the FY 2021 level surpassed the FY 2010 peak (Table SRD-5). Nonetheless, whether tracked in current or constant dollars, federal funding has consistently increased in FYs 2017–21.

The federal budget-making process continued to be tested by competing interests during these years. But when the final spending bills emerged, Congress had conferred significant year-over-year increases in R&D funding.[29] A second consideration, and a main reason for the large year-over-year federal funding increases in FYs 2020 and 2021, has been the regular agency and supplemental funding enacted by Congress to enable R&D responsive to the COVID-19 pandemic.[30]

Finally, **Figure RD-16** charts federal funding for R&D and R&D plant for each of the nine agencies from FY 2008 to FY 2021. (Note that the abovementioned change in the official data to account for the narrowed definition of development—particularly affecting DOD—are reflected in the data for FYs 2016–21.)

Figure RD-16

Federal obligations for R&D and R&D plant, total and for selected agencies: FYs 2008–21



DOC = Department of Commerce; DOD = Department of Defense; DOE = Department of Energy; DOT = Department of Transportation; HHS = Department of Health and Human Services; NASA = National Aeronautics and Space Administration; NSF = National Science Foundation; USDA = Department of Agriculture; VA = Department of Veterans Affairs.

Note(s):
The agencies included in this chart all had annual R&D obligations of $1 billion or more in FY 2020 and together account for the vast majority of the R&D and R&D plant total. Data for FY 2021 are preliminary and may later be revised. Data for FYs 2009 and 2010 include obligations from the additional federal R&D funding appropriated by the American Recovery and Reinvestment Act of 2009. Beginning in FY 2016, agency reports of obligations for R&D incorporated the Office of Management and Budget's narrowed definition of *development* (Circular A-11, Section 84). This change in definition applies to all agencies, but the main impact has been that DOD's Operational Systems Development (Budget Activity 7) is no longer included as development. Accordingly, the federal R&D obligations totals shown above for FYs 2016–21 (shaded in the graphic) are not directly comparable with those for FY 2015 and earlier years. The data for FYs 2020 and 2021 include the additional funding provided by supplemental COVID-19 related appropriations in these years.

Source(s):
National Center for Science and Engineering Statistics, Survey of Federal Funds for Research and Development, Volume 70, FYs 2020–21.

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The substantial decline of DOD's R&D obligations in the period of FYs 2011–15 was mainly an intended result of the Budget Control Act of 2011 and related agreements central to the policy debate surrounding the federal spending bills for FYs 2011–15. Both DOE and NASA had some funding increases over this period, but the gains were generally more modest for the other agencies.

In the FYs 2016–21 period (against the reset FY 2016 baseline), the large and consistent year-over-year increases for DOD and HHS are evident—and particularly, the COVID-19-related FYs 2020 and 2021. DOE R&D was also on a rising path throughout this period, but NASA's expansion faltered later in the period. The levels of federally funded R&D by the other major agencies have exhibited only gradual increases.

Distribution of Federal Funding of R&D, by Performer and Type of R&D

Table RD-16 and **Table RD-17** (and Table SRD-6) provide a breakdown by agency of the $173.6 billion of federal dollars obligated for R&D and R&D plant in FY 2020 according to purpose (R&D conduct and R&D plant), performers funded (intramural and extramural), and type of R&D (basic research, applied research, and experimental development).

Table RD-16

Federal obligations for R&D and R&D plant, by agency and performer: FY 2020

(Millions of dollars and percentage of total performers)

Agency	Total	R&D	R&D plant	Total by performers			
				Intramural and FFRDCs	Percentage of total	Extramural performers	Percentage of total
All agencies	173,552.9	167,402.8	6,150.1	69,611.2	40.1	103,941.6	59.9
Department of Defense	67,006.8	66,695.0	311.7	24,786.1	37.0	42,220.7	63.0
Department of Health and Human Services	61,774.8	60,005.7	1,769.0	21,762.9	35.2	40,011.8	64.8
Department of Energy	15,778.0	13,453.0	2,325.0	10,347.0	65.6	5,431.0	34.4
National Aeronautics and Space Administration	10,573.6	10,537.8	35.8	4,835.0	45.7	5,738.7	54.3
National Science Foundation	6,792.5	6,351.2	441.4	287.6	4.2	6,504.9	95.8
Department of Agriculture	3,433.5	2,643.6	789.8	2,479.6	72.2	953.9	27.8
Department of Commerce	1,980.9	1,621.7	359.1	1,576.2	79.6	404.7	20.4
Department of Veterans Affairs	1,565.1	1,565.1	0.0	1,565.1	100.0	0.0	0.0
Department of Transportation	1,224.5	1,184.2	40.3	298.1	24.3	926.4	75.7
Department of the Interior	844.4	837.2	7.2	722.2	85.5	122.2	14.5
Department of Homeland Security	507.5	507.5	0.0	224.5	44.2	283.0	55.8

Table RD-16

Federal obligations for R&D and R&D plant, by agency and performer: FY 2020

(Millions of dollars and percentage of total performers)

Agency	Total	R&D	R&D plant	Total by performers			
				Intramural and FFRDCs	Percentage of total	Extramural performers	Percentage of total
Environmental Protection Agency	493.0	488.5	4.5	246.0	49.9	247.0	50.1
Patient-Centered Outcomes Research Trust Fund	469.7	469.7	0.0	0.0	0.0	469.7	100.0
Smithsonian Institution	276.0	209.8	66.2	276.0	100.0	0.0	0.0
Department of Education	240.1	240.1	0.0	10.5	4.4	229.6	95.6
Agency for International Development	194.3	194.3	0.0	19.7	10.2	174.6	89.8
Department of Justice	96.4	96.4	0.0	10.9	11.3	85.5	88.7
Social Security Administration	69.7	69.7	0.0	37.2	53.4	32.5	46.6
All other agencies	232.0	232.0	0.0	126.6	54.6	105.4	45.4

FFRDC = federally funded research and development center.

Note(s):
Table lists all agencies covered in Table RD-15 and as ranked there. R&D is basic research, applied research, and experimental development, and it does not include R&D plant. Intramural activities include actual intramural R&D performance and costs associated with planning and administration of both intramural and extramural programs by federal personnel. Extramural performers includes federally funded R&D performed in the United States and U.S. territories by businesses, universities and colleges, other nonprofit institutions, state and local governments, and foreign organizations. All other agencies includes Department of Housing and Urban Development, Department of Labor, Department of State, Department of the Treasury, Administrative Office of the U.S. Courts, Appalachian Regional Commission, Consumer Product Safety Commission, Federal Communications Commission, Federal Trade Commission, Library of Congress, National Archives and Records Commission, Nuclear Regulatory Commission, Tennessee Valley Authority, RESTORE Act Centers, U.S. Agency for Global Media, and U.S. Postal Service.

Source(s):
National Center for Science and Engineering Statistics, Survey of Federal Funds for Research and Development, Volume 70, FYs 2020–21.

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Table RD-17

Federal obligations for R&D, by agency and type of R&D: FY 2020

(Millions of dollars and percentage of total R&D)

Agency	Total R&D	Basic research	Applied research	Experimental development	Percentage of total R&D		
					Basic research	Applied research	Experimental development
All agencies	167,402.8	41,546.6	43,758.1	82,098.0	24.8	26.1	49.0
Department of Defense	66,695.0	2,499.1	6,416.2	57,779.7	3.7	9.6	86.6
Department of Health and Human Services	60,005.7	21,809.0	22,424.8	15,772.0	36.3	37.4	26.3
Department of Energy	13,453.0	5,501.6	5,023.6	2,927.9	40.9	37.3	21.8
National Aeronautics and Space Administration	10,537.8	3,839.4	2,554.8	4,143.7	36.4	24.2	39.3
National Science Foundation	6,351.2	5,461.9	889.2	0.0	86.0	14.0	0.0
Department of Agriculture	2,643.6	1,163.8	1,224.6	255.2	44.0	46.3	9.7
Department of Commerce	1,621.7	251.2	1,109.6	260.9	15.5	68.4	16.1
Department of Veterans Affairs	1,565.1	617.7	918.1	29.3	39.5	58.7	1.9
Department of Transportation	1,184.2	0.0	900.2	284.0	0.0	76.0	24.0
Department of the Interior	837.2	83.9	614.5	138.9	10.0	73.4	16.6

Table RD-17

Federal obligations for R&D, by agency and type of R&D: FY 2020

(Millions of dollars and percentage of total R&D)

Agency	Total R&D	Basic research	Applied research	Experimental development	Percentage of total R&D		
					Basic research	Applied research	Experimental development
Department of Homeland Security	507.5	47.4	177.9	282.2	9.3	35.0	55.6
Environmental Protection Agency	488.5	0.0	411.9	76.6	0.0	84.3	15.7
Patient-Centered Outcomes Research Trust Fund	469.7	0.0	469.7	0.0	0.0	100.0	0.0
Department of Education	240.1	53.7	135.8	50.7	22.3	56.6	21.1
Smithsonian Institution	209.8	209.8	0.0	0.0	100.0	0.0	0.0
Agency for International Development	194.3	0.1	134.8	59.4	0.1	69.4	30.6
Department of Justice	96.4	0.7	83.8	11.9	0.7	86.9	12.4
Social Security Administration	69.7	0.0	69.7	0.0	0.0	100.0	0.0
All other agencies	232.0	7.4	199.0	25.6	3.2	85.8	11.0

Note(s):
Table lists all agencies covered in Table RD-15 and as ranked there. Detail may not add to total due to rounding. All other agencies includes the Department of Housing and Urban Development, Department of Labor, Department of State, Department of the Treasury, Administrative Office of the U.S. Courts, Appalachian Regional Commission, Consumer Product Safety Commission, Federal Communications Commission, Federal Trade Commission, Library of Congress, National Archives and Records Commission, Nuclear Regulatory Commission, Tennessee Valley Authority, RESTORE Act Centers, U.S. Agency for Global Media, and U.S. Postal Service.

Source(s):
National Center for Science and Engineering Statistics, Survey of Federal Funds for Research and Development, Volume 70, FYs 2020–21.

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For all the agencies together, nearly all of the obligations total was for the purpose of R&D conduct ($167.4 billion, or 96%) (**Table RD-16**; Table SRD-6). Spending on R&D plant was just 3% of the annual total ($6.2 billion), with most of the obligations in this category coming from a few agencies (mainly DOE and HHS, but also NSF, DOD, and DOC).

The agencies differ considerably in the extent to which their R&D is conducted by their own intramural laboratories and affiliated FFRDCs rather than funding provided to extramural R&D performers (e.g., businesses, universities and colleges, nonprofit organizations, state and local governments, and foreign organizations). In FY 2020, for all of the agencies together, 40% of the R&D funding was to agency intramural R&D facilities and FFRDCs, and 60% was to extramural performers (**Table RD-16**). But some agencies are mainly funders of extramural R&D: for example, NSF (96%), HHS (65%), and DOT (76%). Some agencies fund mainly intramural R&D and FFRDCs: VA (100%), DOC (80%), and DOE (66%). The others rely on a mix of intramural and extramural. (Greater detail on the split of the FY 2020 obligated funds for R&D across the agencies and by type of performer can be found in Table SRD-6.)

Regarding the split among type of R&D, the largest share of federal funding in FY 2020 was for experimental development (49%); next was applied research (26%), and then basic research (25%) (**Table RD-17**). These proportions vary widely, however, from agency to agency—mainly reflecting differences in agency missions and priorities. For example, the share of basic research for NSF in 2020 was 86% and 36% for HHS, but its share was only 4% for DOD and close to 0% for DOT.

Corresponding data tables in earlier editions of *Indicators* (NSB ***Indicators 2016***, ***Indicators 2018***, ***Indicators 2020***) show largely the same picture for these distributions of federal funding by agency, performer, and type of R&D.

Distribution of Federal Funding for Research, by S&E Fields

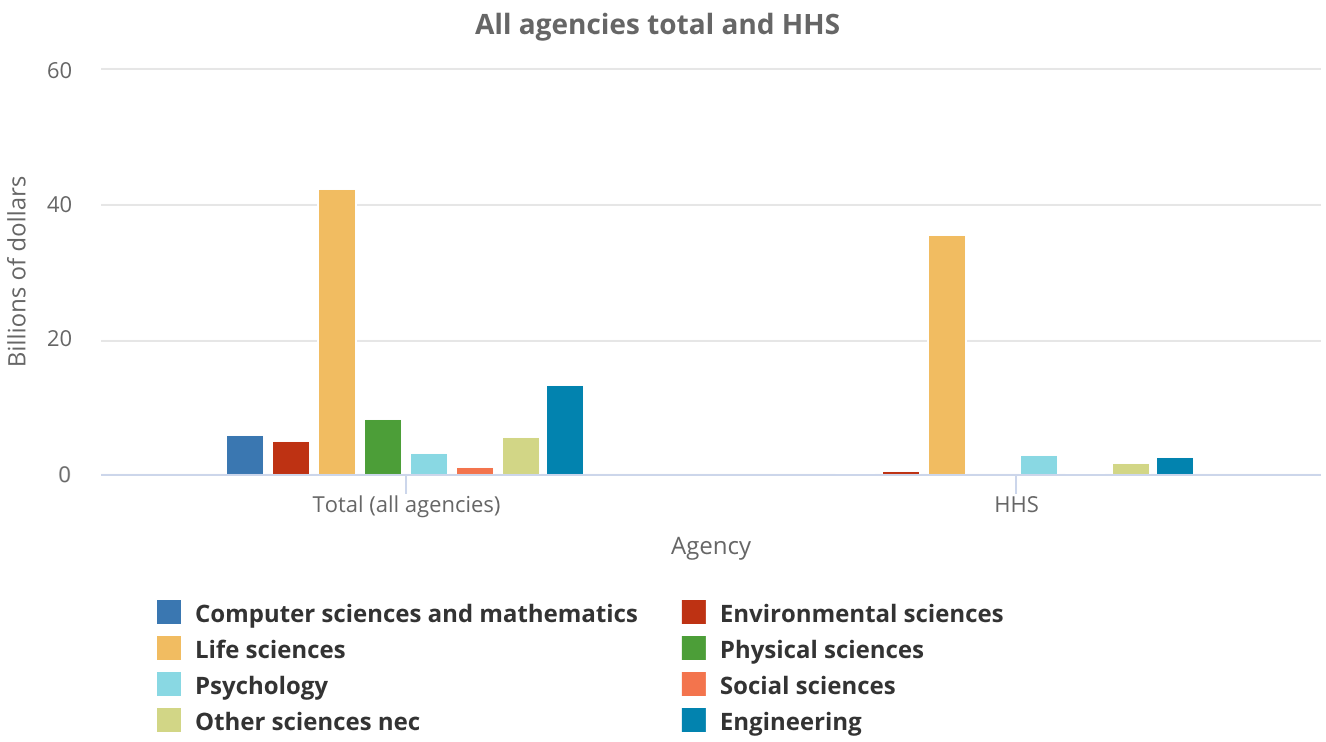
The basic research and applied research conducted or funded by the federal government span a full range of S&E fields: computer sciences and mathematics, environmental sciences, life sciences, physical sciences, psychology, social sciences, engineering, and other S&E fields. Experimental development has not to date been classifiable by S&E field; accordingly, the available data cover only research.[31]

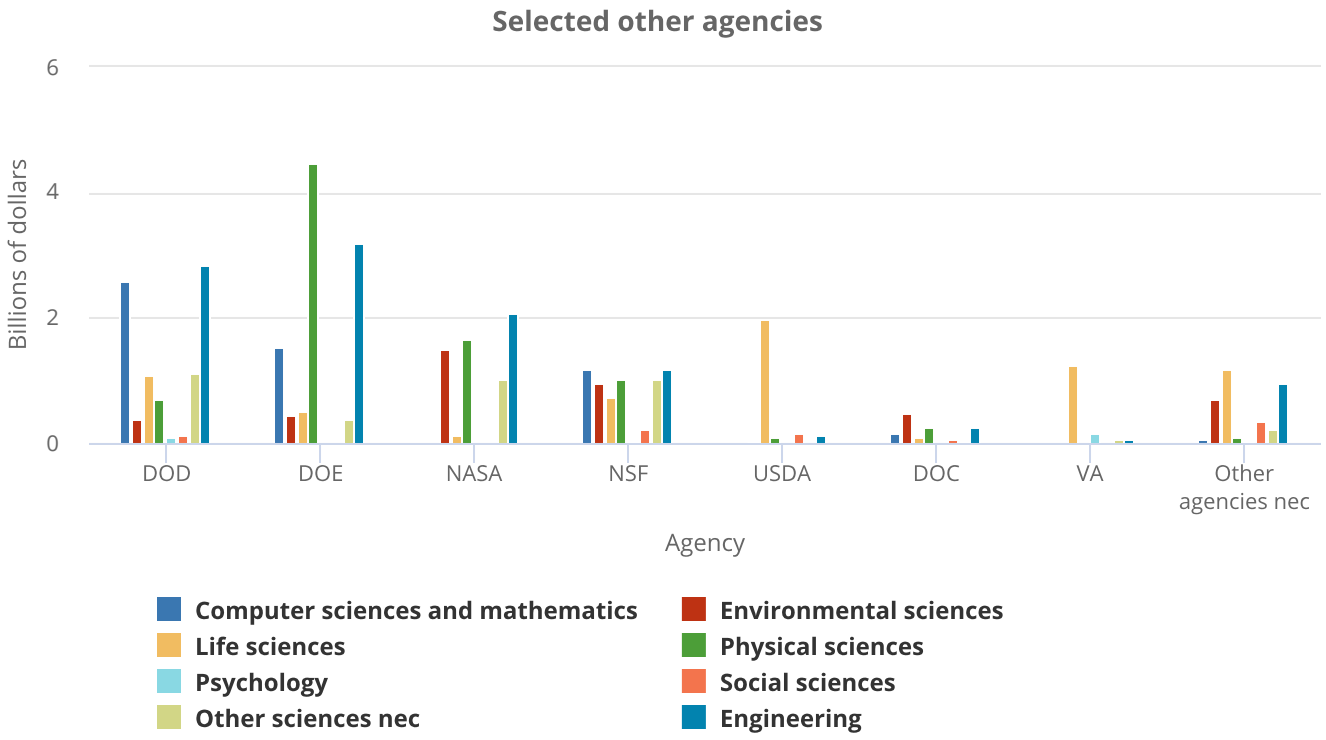
In FY 2020, funding for basic and applied research combined accounted for $85.3 billion of the $167.4 billion total of federal obligations for R&D (**Table RD-17**). Nearly 50% of this amount, $42.5 billion, supported research in life sciences (Table SRD-7). The fields with the next-largest amounts were engineering ($13.2 billion, or 16%) and physical sciences ($8.4 billion, or 10%), followed by computer sciences and mathematics ($5.9 billion, or 7%), and environmental sciences ($5.0 billion, or 6%). The balance of federal obligations for research in FY 2020 supported psychology, social sciences, and all other sciences ($10.2 billion overall, or 12% of the total for research).

The differences in federal funding for research across agencies and fields reflect the varied agency missions (**Figure RD-17**; Table SRD-7). HHS accounted for the largest share (52%) of federal obligations for research in FY 2020. Most of this amount funded research in life sciences, primarily through the National Institutes of Health (NIH). The seven next-largest federal agencies for research funding that year were DOE (12%), DOD (11%), NASA (8%), NSF (7%), USDA (3%), VA (2%), and DOC (2%).

Figure RD-17

Federal obligations for research, by agency and major S&E field: FY 2020





DOC = Department of Commerce; DOD = Department of Defense; DOE = Department of Energy; HHS = Department of Health and Human Services; NASA = National Aeronautics and Space Administration; nec = not elsewhere classified; NSF = National Science Foundation; USDA = Department of Agriculture; VA = Department of Veterans Affairs.

Note(s):
The scales differ for total (all agencies) and HHS compared with the scales for the other agencies listed. Research includes basic and applied research. See also Table SRD-7.

Source(s):
National Center for Science and Engineering Statistics, Survey of Federal Funds for Research and Development, Volume 70, FYs 2020–21.

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DOE primarily funded research in the physical sciences ($4.5 billion), engineering ($3.2 billion), and computer sciences and mathematics ($1.5 billion). DOD's research focuses included engineering ($2.8 billion), computer sciences and mathematics ($2.6 billion), life sciences ($1.1 billion), and physical sciences ($0.7 billion). NASA focused primarily on engineering ($2.1 billion), physical sciences ($1.7 billion), and environmental sciences ($1.5 billion).

NSF (charged with "promoting the progress of science") had a comparatively diverse $6.4 billion research portfolio that allocated about $0.8 billion–$1.2 billion to each of the following fields: computer sciences and mathematics, environmental sciences, engineering, physical sciences, and life sciences. Smaller amounts were allocated to psychology, social sciences, and other sciences. USDA's $2.4 billion was directed primarily at life (agricultural) sciences ($2.0 billion). The VA's $1.5 billion was also primarily directed at life sciences ($1.2 billion). DOC's $1.4 billion was distributed mainly in the fields of environmental sciences, physical sciences, engineering, and computer sciences and mathematics.

Adjusted for inflation, the total of federal funds obligated for research across all S&E fields grew, on average, by 3.8% annually during 1990–2000 and by 3.0% during 2000–10 (Table SRD-8). More recently, however, the rate of annual growth in the total of research obligations has noticeably slowed. During the period of 2010–20, research obligations increased, on average, by only 1.2% annually, adjusted for inflation. In this most recent period, the average annual growth of research funding in computer sciences and mathematics (3.9%), environmental sciences (2.5%), psychology (2.5%), and physical

sciences (1.9%) each outpaced the rate for research as a whole (1.2%)—and, in some cases, considerably so. The average pace of expansion for research obligations for both the life sciences (0.6%) and engineering (0.1%) has been slower over the period than for research as a whole, although the dollar levels in these two categories are much larger than the others. Research obligations in the social sciences have generally been on a declining path over the period (-2.2%).

Cross-National Comparisons of Government R&D Priorities

Government funding is a feature of most countries' overall R&D systems, where the levels and priorities are typically significant national policy choices. Member countries of the OECD routinely report statistics on government funding of R&D through the government budget allocations for R&D (GBARD) indicator, which distinguishes more than a dozen differing socioeconomic objectives.[32]

Defense is an objective for government funding of R&D for all of the top R&D-performing countries, but the shares vary considerably (**Table RD-18**). Defense accounted for 47% of U.S. federal R&D support in 2019, while South Korea (16%) and the United Kingdom (11%) were a distant second and third.[33] The remaining countries' shares were 4% or lower.

Table RD-18

Government R&D support, by major socioeconomic objectives, for selected countries or regions: Selected years, 2000–19

(Millions of U.S. dollars and percent)

Country or region	Year	GBARD (current PPP US$millions)	Percentage of GBARD		Percentage of nondefense					
			Defense	Nondefense	Economic development programs	Health and environment	Education and society	Civil space	Non-oriented research	General university funds
United States	2000	72,681.0	44.4	55.6	13.4	49.9	1.8	20.9	13.8	na
	2010	119,382.0	46.7	53.3	12.5	56.1	1.6	12.9	16.9	na
	2019	149,971.0	46.9	53.1	12.8	56.4	1.5	12.7	16.5	na
EU-27	2000	63,857.3	9.8	90.2	22.6	9.7	3.3	6.7	19.0	37.8
	2010	103,142.4	5.0	95.0	23.8	12.1	6.7	5.7	17.8	33.5
	2019	134,498.4	2.4	97.6	20.6	12.6	4.9	5.8	18.0	35.9
France	2000	14,884.5	21.4	78.6	17.7	9.7	1.1	13.2	27.4	28.5
	2010	19,157.7	14.7	85.3	21.1	12.6	5.3	12.7	19.6	27.0
	2019	20,923.5	1.2	98.8	13.5	13.9	1.3	12.0	22.1	24.0
Germany	2000	17,239.1	7.8	92.2	21.6	9.4	3.9	5.1	17.5	42.4
	2010	28,611.2	5.0	95.0	24.4	9.2	4.4	5.0	17.0	40.6
	2019	45,600.7	4.4	95.6	23.5	10.1	4.6	4.7	15.9	41.2
United Kingdom	2000	9,495.0	35.6	64.4	14.2	27.7	6.3	3.4	18.3	29.7
	2010	13,327.1	18.2	81.8	8.5	32.3	5.0	2.1	22.0	30.1
	2019	18,072.0	11.4	88.6	23.1	29.6	5.7	1.4	14.2	26.0
Japan	2000	21,227.8	4.1	95.9	33.4	6.6	1.0	5.8	14.6	37.0
	2010	32,140.4	4.8	95.2	27.6	7.4	0.9	7.1	21.0	35.9
	2019	40,934.9	3.0	97.0	34.3	11.8	0.7	5.7	20.6	26.8
South Korea	2000	5,014.6	20.5	79.5	53.4	14.8	3.8	3.1	24.9	**
	2010	16,297.9	13.3	86.7	52.1	13.7	2.4	2.7	29.1	**
	2019	24,008.6	16.3	83.7	48.6	15.4	8.2	2.2	25.7	**

** = included in other categories; na = not applicable.

EU = European Union; GBARD = government budget allocations for R&D; PPP = purchasing power parity.

Note(s):
The most recent year for which all the selected countries could provide complete data is 2019. Foreign currencies are converted to U.S. dollars through PPPs. The GBARD statistics reported for the United States are federal budget authority data. GBARD data are not yet available for China or India. The socioeconomic objective categories are aggregates of the 14 categories identified by Eurostat's 2007 Nomenclature for the Analysis and Comparison of Scientific Programs and Budgets (NABS) (Eurostat 2007). The figures are as reported by the Organisation for Economic Co-operation and Development.

Source(s):
Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (September 2021 edition).

Science and Engineering Indicators

Nondefense R&D priorities also vary by country. For the United States and the United Kingdom in 2019, health and the environment have been the largest shares of nondefense spending, at 56% and 30%, respectively. These shares have remained at these relatively high levels since 2000.

South Korea has consistently allocated about half of its nondefense R&D support to economic development programs, which for them encompass agriculture, energy, fisheries and forestry, industry, transportation, telecommunications, and other infrastructure. Japan has allocated around a third of its nondefense R&D support to this objective. The shares devoted by other countries are markedly less.

The civil space objective accounted for about 13% of nondefense federal R&D funding in the United States in 2019. The share was 21% in 2000 and declined thereafter to 13% in 2010. The corresponding share in France was 12% for 2019, although it was somewhat higher, around 13%, in both 2000 and 2010. The civil space share is 6% or below for the rest of the top R&D-performing countries.

Both the non-oriented research funding and general university funds (GUF) objectives reflect government support for R&D by academic, government, and other performers directed chiefly at the "general advancement of knowledge" in the natural sciences, engineering, social sciences, humanities, and related fields. For some of the countries, the sum of these two objectives represents by far the largest part of nondefense GBARD: in 2019, Germany (57%), France (46%), Japan (47%), the United Kingdom (40%), and South Korea (26%). While the corresponding 2019 share for the United States (17%) is substantially smaller, it requires interpretive caution. Cross-national comparisons of these two indicators can be difficult because some countries (notably the United States) do not use the GUF mechanism to fund R&D for general advancement of knowledge or do not separately account for GUF (like South Korea). More typically, these countries direct R&D funding to project-specific grants or contracts, which are then assigned to more specific socioeconomic objectives.[34]

Finally, the education and society objective amounts to a comparatively small component of nondefense government R&D funding for the top R&D-performing countries. This objective comprised 2% of nondefense GBARD in the United States in 2019, compared to a lower share in Japan (1%) and to higher shares in Germany (5%), the United Kingdom (6%), and South Korea (8%).

Conclusion

The previous edition of this report (released January 2020, as part of *Indicators 2020*) offered several broad conclusions about the status of the U.S. R&D system: (1) the annual total of U.S. R&D performance is back on a strong, sustained expansionary path (since 2010); (2) the United States remains the world's top R&D performer and conducts much more basic research than other countries, although China is moving ever closer to the United States in the spending magnitude of its overall R&D effort; and (3) the U.S. and European shares of the global R&D total continue to erode as those of countries in East-Southeast and South Asia increase. The data presented in this report reinforce these findings.

Prior sections of this 2022 edition of the report provide a detailed update of relevant trends in each of these areas. One broad finding is that the expansionary trend of U.S. R&D performance, as measured by dollar expenditures, remains and appears to be gaining further steam, with larger year-over-year increases in the most recent years, along with a rise of the nation's R&D-to-GDP ratio to above 3.0%. A second finding is that the United States remains the world's top R&D-performing country as well as performing the most basic research. China remains a close competitor, but in the latest statistics (revised since our 2020 report), the gap is larger than previously reported. (In 2019, the United States spent $667 billion, and China accounted for $526 billion.) Nonetheless, the growth rate of China's overall R&D enterprise continues to expand yearly, on average, at twice the rate of the United States. With China's exceptional growth and the strong increases of other Asian countries, such as Japan, South Korea, India, and Taiwan, the global geography of R&D continues to shift to East-Southeast and South Asia.

In 2019, the business sector remained the predominant performer and funder of U.S. R&D. The sector's ever-higher levels of performance have accounted for about 80% or more of the year-over-year increase of the U.S. R&D total since 2010. Nevertheless, the presence and consistency, year after year, of federal funding support for R&D performed by all sectors has been an essential force in the functioning of the U.S. R&D system. Even so, the data continue to show that the share of U.S. R&D performance funded by the federal government overall has been declining since 2010. This decline is, in part, a consequence of the large increases in R&D funding from the business sector in recent years. Nonetheless, it indicates that federal funding has not kept up with the increases in other sectors.

Glossary

Definitions

European Union (EU-27): With the exit of the United Kingdom in 2020, the EU comprises 27 member nations: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden. Unless otherwise noted, data on the EU include all 27 nations.

Organisation for Economic Co-operation and Development (OECD): An international organization of 37 countries, headquartered in Paris, France. The member countries are Australia, Austria, Belgium, Canada, Chile, Colombia, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. Among its many activities, OECD compiles social, economic, and science and technology statistics for all member and selected nonmember countries. Costa Rica became the 38th member of the OECD in May 2021; however, the country's data have not yet been included in OECD's Main Science and Technology Indicators.

Research and experimental development (R&D): R&D comprises creative and systematic work undertaken to increase the stock of knowledge—including knowledge of humankind, culture, and society—and to devise new applications of available knowledge (OECD 2015).

> **Basic research:** Experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.
>
> **Applied research:** Original investigation undertaken in order to acquire new knowledge; directed primarily toward a specific, practical aim or objective.
>
> **Experimental development:** Systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes.

R&D intensity: A measure of R&D expenditures relative to size, production, financial, or other characteristics for a given R&D-performing unit (e.g., country, sector, company). Examples include the R&D-to-GDP ratio, which is widely used as the measure of a nation's overall R&D intensity, and R&D-to-sales ratio, which is frequently used to gauge the R&D intensity of a business or industry.

R&D plant: Includes both facilities and major equipment necessary for the execution of an R&D program. These include the purchase, construction, manufacture, rehabilitation, or major improvement of physical assets, such as land, major fixed equipment, and supporting infrastructure like a sewer line or housing at a remote location. R&D plant also includes the acquisition, design, or production of major movable equipment, such as mass spectrometers, research vessels, DNA sequencers, and other movable major instruments for use in R&D activities.

Key to Acronyms and Abbreviations

ANBERD: Analytical Business Enterprise R&D

COVID-19: coronavirus disease 2019

EU: European Union

FFRDC: federally funded research and development center

FY: fiscal year

GBARD: government budget allocations for R&D

GERD: gross domestic expenditures on R&D

GDP: gross domestic product (see [BEA 2015])

GUF: general university funds

ISIC: International Standard Industrial Classification of All Economic Activities

NAICS: North American Industry Classification System

NCSES: National Center for Science and Engineering Statistics

OECD: Organisation for Economic Co-operation and Development

PPP: purchasing power parity

R&D: research and experimental development

S&E: science and engineering

UNESCO: United Nations Educational, Scientific, and Cultural Organization

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Notes

1 These data time series and additional statistics are part of the NCSES *National Patterns of R&D Resources* series released yearly and can be accessed on the NCSES website at **https://www.nsf.gov/statistics/natlpatterns/**. In addition to the data presented in this section's figures and tables, NCSES statistics on U.S. R&D performance go back to 1953 and provide details by R&D performers, funders, and type of R&D.

2 In this report, dollars adjusted for inflation (i.e., constant dollars) are based on the GDP implicit price deflator (currently in 2012 dollars) as published by the Department of Commerce, Bureau of Economic Analysis (BEA) (**https://www.bea.gov/iTable/index_nipa.cfm**). Note that GDP deflators are calculated on an economy-wide scale and do not explicitly gauge R&D.

3 Due to sample variability in the data for the business R&D component (particularly the variability for 2000), the compound annual growth rate of the U.S. R&D total over the 2000–10 period fails (but only barely so) to exceed the corresponding rate of growth of GDP at a 90% confidence level.

4 Due to sample variability in the data for the business R&D component, the calculated R&D-to-GDP ratios for 1964, 2009, and 2017 are not significantly different from one another at a 90% confidence level.

5 Starting in 2016, the business R&D data reported by the *National Patterns* series include the R&D expenditures reported by microbusinesses (generally, companies with fewer than 10 employees). These new data come from NCSES surveys fielded for 2016 and onward: the 2016 Business R&D and Innovation Survey–Microbusiness, which collected statistics on the R&D activities of businesses with 1–4 employees, and for 2017–19, the Annual Business Survey (ABS), which collected statistics on the R&D activities of businesses with 1–9 employees. The totals for business R&D performance are $4 billion to $5 billion higher for 2016 and beyond as a result of this microbusiness R&D being included.

6 The data for higher education R&D appearing in this report adjust the academic fiscal year basis of NCSES's Higher Education Research and Development Survey data to calendar year and net out pass-throughs of research funds to remove double counting in the national totals (see NCSES *National Patterns of R&D Resources*: **https://www.nsf.gov/statistics/natlpatterns/**). Accordingly, the higher education data included in this report differ from those cited in the *Indicators 2022* thematic report "[2022] Academic Research and Development."

7 FFRDCs are R&D-performing organizations that are exclusively or substantially financed by the federal government. An FFRDC is operated to provide R&D capability to serve federal agency mission objectives or, in some cases, to provide major facilities at universities for research and associated training purposes. Each FFRDC is administered by an industrial firm, a university, a nonprofit institution, or a consortium. NCSES maintains a current Master Government List of Federally Funded R&D Centers. For information on the current FFRDC count, along with its history, see **https://www.nsf.gov/statistics/ffrdclist/**.

8 An additional factor affecting the reported level of federal intramural R&D performance in 2016 and beyond is OMB's adoption in 2016 of a definition of *development* that narrowed what is counted to *experimental development*. The largest effect has been the exclusion of DOD's Budget Activity 6.7, Operational Systems Development, from the federal tally of R&D expenditures. As a result, the federal intramural R&D totals reported for 2016 and beyond (in **Figure RD-2**, **Table RD-1**, and elsewhere in this report) are approximately $5 billion lower than they would have been if tallied in the same way as 2015 and earlier. For a further discussion of this technical development in federal R&D reporting, see this report's section **Recent Trends in Federal Support for U.S. R&D**.

9 R&D funding by business in this section refers to business funding for domestic business R&D performance plus business funding for FFRDCs and U.S. academic and nonprofit R&D performers.

10 R&D encompasses a wide range of activities, from research yielding fundamental knowledge in the physical, life, and social sciences; to research addressing national defense needs and such critical societal issues as global climate change, energy efficiency, and health care; to the development of platform or general-purpose technologies that can enable the creation and commercial application of new and improved goods and services. The most widely applied classification of these activities characterizes R&D as *basic research*, *applied research*, or *experimental development* (OECD 2015; OMB 2016; NSF 2018). This longstanding trio of categories has been criticized over the years as reinforcing the idea that creating new knowledge, invention, and innovation is a linear process beginning with basic research, followed by applied research and then development, and ending with the production and diffusion of new technologies and eventually commercially significant innovations. Nonetheless, alternative classifications that provide measurable distinctions, capture major differences in types of R&D, and are widely accepted as superior have yet to be developed. Despite the recognized limitations of the basic research–applied research–development classification framework, it remains useful in providing indications of differences in the motivation, expected time horizons, outputs, and types of investments associated with R&D projects.

11 The Organisation for Economic Co-operation and Development notes that in measuring R&D, one source of error is the difficulty of locating the dividing line between experimental development and the further downstream developmental activities needed to realize an innovation (OECD 2015:51–52). Most definitions of R&D set the cutoff at the point when a particular product or process reaches *market readiness*. At this point, the defining characteristics of the product or process are substantially set—at least for manufactured goods, if not also for services—and further work is aimed primarily at developing markets, engaging in preproduction planning, and streamlining the production or control system.

12 The data presented in this paragraph come from NCSES *National Patterns of R&D Resources*, annual series, 2010–20.

13 The arithmetic is straightforward to calculate type-of-R&D shares for past years, based on the time-series data reported annually in the NCSES *National Patterns of R&D Resources* series. Nonetheless, care must be taken in describing the trends for these shares over time. Although NCSES's sectoral surveys of R&D expenditures have long and consistently used the Organisation for Economic Co-operation and Development *Frascati Manual*'s type-of-R&D definitions (OECD 2015), the survey instruments have occasionally been revised to improve the reliability of the responses received, most notably in the academic, business, federal funds, and FFRDC R&D expenditure surveys. Accordingly, some differences observed in the shares directly calculated from the supplemental table time-series data more nearly reflect the effects of these improvements in the type-of-R&D survey questions than changes in the type-of-R&D shares among R&D performers.

14 NCSES's estimates for total global R&D are based on OECD's *Main Science and Technology Indicators* (September 2021 edition) and from R&D statistics for additional countries assembled by UNESCO's Institute for Statistics (March 2021 release). Presently, no database on R&D spending is comprehensive and consistent for all nations performing R&D. The OECD and UNESCO databases together provide R&D performance statistics for 163 countries, although the data are not current or complete for all. NCSES's estimate of total global R&D reflects 119 countries, with reported annual R&D expenditures at or above $50 million annually, which accounts for most of the current global R&D.

15 U.S. GERD in this section differs slightly from the U.S. total R&D reported in the U.S. trends section. For consistency with international standards, U.S. GERD includes federal capital funding for federal intramural and nonprofit R&D (typically totaling just over $1 billion annually) in addition to what is reported as U.S. total R&D.

16 The International Comparison Program (ICP) is a global statistical initiative established to produce, among other measures, PPPs and internationally comparable price level indexes. It is managed by the World Bank with the support of the United Nations Statistical Commission. It is the largest data collection initiative for global price data. More information on the program is available at **https://www.worldbank.org/en/programs/icp**.

17 The ICP 2017 results were released in May of 2020. As part of this release, the 2011 benchmark data were also revised to incorporate updated data on expenditures, regional PPPs, population, and market exchange rates. More information on the data, methodology, and ICP revision policy is available at **https://www.worldbank.org/en/programs/icp**.

18 For more information on the NCSES business R&D surveys, refer to the **Technical Appendix** accompanying this report.

19 In 2010, 86% of companies reported domestic R&D performed and paid for by the company related to only one business activity. Similar findings are reported in a more recent analysis by Jankowski and Shackelford (2019). See both references for an in-depth analysis of industry classification methods.

20 See, for example, Knott and Vieregger (2020) for a recent discussion on the relationship between company size, R&D performance, and innovation.

21 In addition to the changes described in this paragraph, in 2015, following international guidance (OECD 2015), NCSES also implemented an updated size classification structure based on reported employment for business R&D.

22 The BRDI-M survey was conducted only once. Most questions from this survey are now included in the ABS.

23 ISIC, Rev.4, was released by the United Nations Statistics Division in August 2008. For an overview of the classification structure, comparisons with earlier editions, and background, see **https://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=27**.

24 For a more complete list of industries, see the OECD ANBERD database.

25 The data reported in this section draw primarily from the NCSES Survey of Federal Funds for Research and Development. The most recent edition is Volume 70, which provides data on actual federal R&D spending (obligations) for FY 2020 and preliminary data for FY 2021. For further details on this survey, see **https://ncses.nsf.gov/pubs/nsf22324**.

26 The analysis in this section focuses primarily on developments in federal R&D priorities and funding support over the course of the last decade. Nevertheless, there is an important and interesting story to tell about how the comparatively minor federal role in the nation's science and research system up until World War II was reconsidered, redirected, and greatly enlarged, starting shortly after the end of the war and moving through the subsequent decades to the present. For a review of the essential elements of this evolving postwar federal role, see Jankowski (2013).

27 For a further account of this recent federal budget history, see Boroush (2015, 2016). Notable among the various interconnected developments over these years were the federal-wide spending reductions imposed by the enacted FY 2011 federal budget: the Budget Control Act of 2011, intended to address the then-ongoing national debt ceiling crisis, which commanded a 10-year schedule of budget caps and spending cuts; the budget sequestration provision, which ultimately took hold in the FY 2013 federal budget; and the Bipartisan Budget Act of 2013, which provided some subsequent relief from the deepening sequestration requirements, but only for the FY 2014 and FY 2015 budgets.

28 For a detailed account of the revision and its impact on federal agencies' reports of their annual R&D spending in FY 2016 and beyond, see Pece and Jankowski (2021).

29 Data on annual federal budget authority for R&D provided in the NCSES report series on Federal R&D Funding by Budget Function (**https://www.nsf.gov/statistics/fedbudget/**) provides perspective. In the president's federal government budget proposal for FY 2018, the proposed level of R&D funding was $117.8 billion; as the funding legislation was enacted by the Congress, the R&D funding total was $144.5 billion. For FY 2019, the president's proposal was $123.7 billion; as enacted by Congress, it was $150.0 billion. In FY 2020, the president's proposal was $142.4 billion, and it was $164.8 billion as enacted by Congress. For FY 2017, the proposed level was $153.9 billion; as enacted, it was $127.3 billion. But interpretation of the federal funding trend for that year is complicated by an OMB-mandated revision in the definition of R&D that reduced the official report of the enacted level of R&D by some $27 billion.

30 For a detailed account, based on recent NCSES data from the Survey of Federal Funds for Research and Development, Volume 70, FYs 2020 and 2021, see Pece (2022). Principal recipients of federal funding for COVID-19 related R&D were the Biomedical Advanced Research and Development Authority (BARDA) in HHS and the Defense Health Agency in DOD.

31 Data collected annually by NCSES on federal R&D funding include detail on the distribution of support for research (i.e., basic and applied research) across differing S&E fields.

32 Government R&D funding statistics compiled annually by OECD provide insights into how national government priorities for R&D differ across countries (OECD 2015). The GBARD indicator provides data on how a country's overall government funding for R&D splits among a set of socioeconomic categories (e.g., defense, health, space, and general research). GBARD statistics are available for the United States and most of the other top R&D-performing countries discussed earlier in this report's section **Cross-National Comparisons of R&D Performance**. (Corresponding GBARD data for China and India, however, are not currently available.)

33 Defense received 50% or more of the federal R&D budget in the United States for many years. The defense share was 63% in 1990 as the Cold War period waned but then dropped in subsequent years. Defense rose again in the first decade of the 2000s—in large part, reflecting post-9/11 security concerns—but it has been declining again in the most recent years. For the other countries, the defense share of government R&D funding has generally declined or remained at a stable, low level.

34 The treatment of GUF is one of the major areas of difficulty in making international R&D comparisons. In many countries, governments support academic research primarily through large block grants that are used at the discretion of each higher education institution to cover administrative, teaching, and research costs. Only the R&D component of GUF is included in national R&D statistics, but problems arise in identifying the amount of the R&D component and the objective of the research. Moreover, government GUF support is in addition to support provided in the form of earmarked, directed, or project-specific grants and contracts (funds that can be assigned to specific socioeconomic categories). In several large European countries (France, Germany, Italy, and the United Kingdom), GUF accounts for 50% or more of total government R&D funding to universities. In Canada, GUF accounts for about 38% of government academic R&D support. Thus, international data on academic R&D reflect not only relative international funding priorities but also funding mechanisms and philosophies regarded as the best methods for financing academic research.

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John Jankowski, National Center for Science and Engineering Statistics

Marty Grueber, TEConomy Partners LLC

Kei Koizumi, White House Office of Science and Technology Policy

John Sargent, Congressional Research Service

Bureau of Economic Analysis

Department of Defense

Department of Homeland Security

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Report Authors

Mark Boroush
Senior Analyst
Research & Development Statistics Program
National Center for Science and Engineering Statistics
mboroush@nsf.gov

Ledia Guci
Science Resources Analyst
Science and Engineering Indicators Program
National Center for Science and Engineering Statistics
lguci@nsf.gov

NCSES

National Center for Science and Engineering Statistics
Directorate for Social, Behavioral and Economic Sciences
National Science Foundation
2415 Eisenhower Avenue, Suite W14200
Alexandria, VA 22314
Tel: (703) 292-8780
FIRS: (800) 877-8339
TDD: (800) 281-8749
ncsesweb@nsf.gov